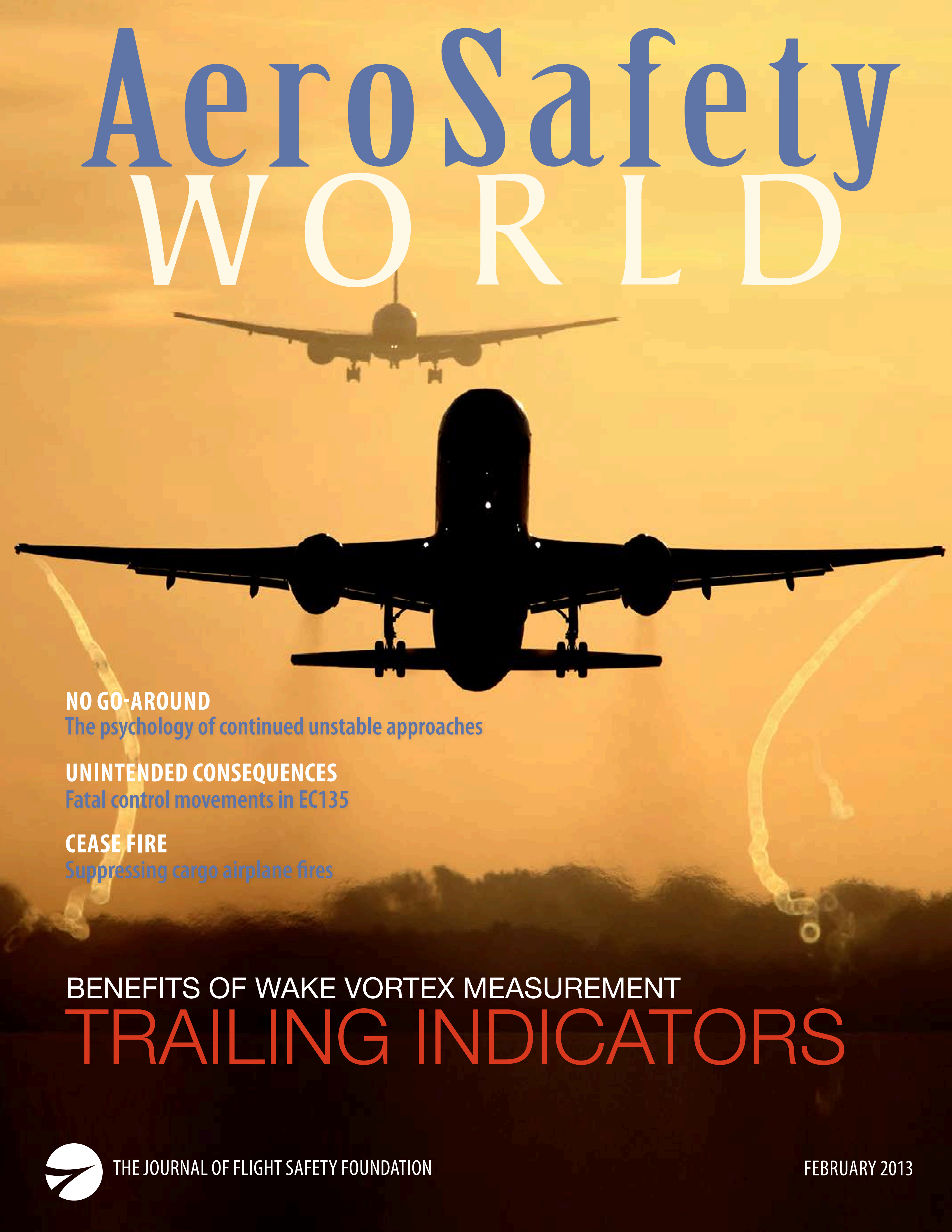
AeroSafety WORLD



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BENEFITS OF WAKE VORTEX MEASUREMENT

TRAILING INDICATORS

THE JOURNAL OF FLIGHT SAFETY FOUNDATION

FEBRUARY 2013

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CHANGE AT The Helm

On Jan. 1, I assumed the helm of the Flight Safety Foundation, the most respected independent and impartial international aviation safety organization in the world. Following in the sizeable footsteps of our founder, the late Jerry Lederer, and the Foundation's most recent president and CEO, Bill Voss, will not be an easy task, but it is a challenge that I sought and about which I am very excited.

Bill's background as a pilot and air traffic controller gave him a well-rounded perspective of the basics of aviation safety. His many years at the U.S. Federal Aviation Administration and the International Civil Aviation Organization gave him an appreciation for what can be achieved when regulators and industry partners work together to improve aviation safety. When he joined the Foundation in November 2006, Bill immediately began visiting state regulators, aviation organizations and industry groups, resulting in dozens of trips annually, hundreds of speeches and presentations, and even more meetings, conferences and one-on-one sessions — all in quest of advancing aviation safety.

His appearances were not limited to the developed world. Bill traveled to areas where help was needed most, where regulators, operators and industry needed to become better informed on safety issues. Sudan and the Middle East were among the places where Bill made a significant difference in how aviation operations and safety are handled.

Traveling on behalf of the Foundation took countless hours away from the office and, most importantly, away from his family. Without his wife, Carol's, support and understanding, that would have not been possible. For that, I would like to recognize and thank her on behalf of the Foundation.

Throughout Bill's tenure at the Foundation, he was known for his insight into individual safety issues. He has a gift for shaping an issue so it can be understood by everyone, inside and outside of the aviation community. For that, we will be forever indebted.

This spring, Bill plans to write one more column for *AeroSafety World*, and to provide us with his unique perspective on global aviation safety and on his tenure at the Foundation. I look forward to reading that piece and seeing and consulting with Bill as he embarks on a new flight path here in Washington.

As the new president and CEO, I am excited to share my thoughts with you each month in this column as I, along with the Foundation Board of Governors and a very dedicated and talented staff, move the Foundation into a new generation!

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

AeroSafetyWORLD

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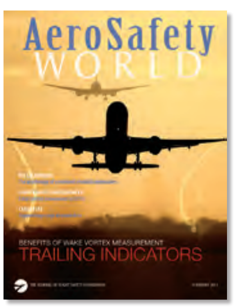

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Share Your Knowledge

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

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AeroSafetyWORLD

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THE RIGHT Decision

Several years ago, my wife and I were flying to the U.S. Virgin Islands for a little mid-winter R&R sans kids. Moments before anticipated touchdown at St. Thomas' Cyril E. King Airport, it flashed through my mind that the airplane was landing long. Almost at that same moment, we heard and felt the roar of the engines as the pilots opted to go around and try again. A little spooked, my wife asked what had just happened. As I explained the concept of a go-around she started to laugh. After years of patiently listening to me blather on about this or that technology or process, she found it funny that "go-around" really is a technical term.

But go-arounds are no laughing matter. Runway excursions account for one-third of all accidents, and the greatest risk factor for excursions is the unstable approach. An unstable approach should result in a go-around, but usually does not. In fact, according to Foundation research, only 3 percent of all unstable approaches result in go-arounds. Why is that?

In 2011, the Foundation launched a Go-Around Decision Making and Execution Project, the intent of which is to mitigate runway excursions caused by unstable approaches by achieving a higher level of pilot compliance with go-around policies. With this issue of *AeroSafety World*, we are beginning a series of articles that will take an in-depth look at the results of the project's work to date. The first article in the series begins on p. 22 and was written by J. Martin Smith, Ph.D.; David W. Jamieson, Ph.D.; and Capt. William F. Curtis of The Presage Group. I'd like to thank all three gentlemen for their work on the Foundation's go-around project and for the hours they put into crafting the article. I'm looking forward to the next installment.

As always, we welcome feedback from our readers.

Kudos and Thanks

While I'm handing out thanks, I want to mention long-time Director of Technical Programs Jim Burin. Careful readers of *ASW* will note on p. 6 that Jim has a new title and is transitioning into the role of Foundation Fellow. We won't be seeing Jim in the office as much, but he will continue to be engaged in the Foundation's activities. In my nearly 10 months at the Foundation, Jim has been an invaluable source of knowledge and ideas, and has never been shy about letting me know what details he likes and doesn't like in *ASW* articles. Sometimes the best medicine is the most difficult to swallow. Thanks, Jim.

Frank Jackman
Editor-in-Chief
AeroSafety World

Serving Aviation Safety Interests for More Than 60 Years

Flight Safety Foundation is an international membership organization dedicated to the continuous improvement of aviation safety. Nonprofit and independent, the Foundation was launched officially in 1947 in response to the aviation industry's need for a neutral clearinghouse to disseminate objective safety information, and for a credible and knowledgeable body that would identify threats to safety, analyze the problems and recommend practical solutions to them. Since its beginning, the Foundation has acted in the public interest to produce positive influence on aviation safety. Today, the Foundation provides leadership to more than 1,000 individuals and member organizations in 150 countries.

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FEB. 8 ➤ ABCs of SMS (free course). Aviation Consulting Group. Honolulu, Hawaii, U.S. Robert Baron, <inquiries@tacgworldwide.com>, <www.tacgworldwide.com/master.htm>, 800.294.0872, +1 954.803.5807.

FEB. 11–15 ➤ Human Factors in Aviation/CRM Instructor Training. Vortex Training Seminars. Denver. Stephanie Brewer, <info@vortexfsm.com>, <www.vortexfsm.com/seminars>, +1 303.800.5526.

FEB. 12–13 ➤ Regulatory Affairs Training. JDA Aviation Technology Solutions. Bethesda, Maryland, U.S. <info@jdasolutions.aero>, <jdasolutions.aero/services/regulatory-affairs.php>, 877.532.2376, +1 301.941.1460.

FEB. 12–14 ➤ World ATM Congress. Civil Air Navigation Services Organisation and Air Traffic Control Association. Madrid. Rugger Smith, <Rugger.Smith@worldatmcongress.org>, <www.worldatmcongress.org/Home.aspx?refer=1>, +1 703.299.2430, ext. 318; Ellen Van Ree, <Ellen.Van.Ree@worldatmcongress.org>, +31 (0)23 568 5387.

FEB. 18–20 ➤ SMS Initial. Curt Lewis & Associates. Seattle. Masood Karim, <masood@curt-lewis.com>, +1 425.949.2120. (Also FEB. 25–27, Dallas.)

FEB. 19–21 ➤ Air Transportation of Hazardous Materials. U.S. Department of Transportation, Transportation Safety Institute. Oklahoma City, Oklahoma, U.S. Lisa Colasanti, <AviationTrainingEnrollment@dot.gov>, <1.usa.gov/YLcjB8>, 800.858.2107, +1 405.954.7751. (Also MAY 2–3, Anchorage, Alaska, U.S.; JULY 30–AUG. 1, Oklahoma City.)

FEB. 21–22 ➤ European Business Aviation Safety Conference. Aviation Screening. Munich, Germany. Christian Beckert, <info@ebascon.eu>, <www.ebascon.eu>, +49 7158 913 44 20.

FEB. 21–22 ➤ Safety Indoctrination: Train the Trainer. Curt Lewis & Associates. Seattle. Masood Karim, <masood@curt-lewis.com>, +1 425.949.2120.

MARCH 1 ➤ ABCs of SMS (free course). Aviation Consulting Group. Myrtle Beach, South Carolina, U.S. Robert Baron, <inquiries@tacgworldwide.com>, <www.tacgworldwide.com/master.htm>, 800.294.0872, +1 954.803.5807.

MARCH 8 ➤ ABCs of SMS (free course). Aviation Consulting Group. San Juan, Puerto Rico. Robert Baron, <inquiries@tacgworldwide.com>, <www.tacgworldwide.com/master.htm>, 800.294.0872, +1 954.803.5807.

MARCH 4–7 ➤ Heli-Expo 2013. Helicopter Association International. Las Vegas. <Heliexpo@rotor.com>, <www.rotor.com/Events/HELIEXPO2013.aspx>, +1 703.683.4646.

MARCH 11–15 ➤ Aircraft Maintenance Investigation. Southern California Safety Institute. San Pedro, California, U.S. Denise Davalloo, <denise.davalloo@scsi-inc.com>, <www.scsi-inc.com/AMI.php>, +1 310.940.0027, ext.104. (Also AUG. 26–30.)

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

MARCH 12–13 ➤ Risk Management. ScandiAvia. Stockholm. <morten@scandiavia.net>, <bit.ly/U9yyPm> , +4791184182.

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

MARCH 18–22 ➤ Investigation Management. Southern California Safety Institute. San Pedro, California, U.S. Denise Davalloo, <denise.davalloo@scsi-inc.com>, <www.scsi-inc.com/IM.php>, +1 310.940.0027, ext.104.

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

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

APRIL 15–17 ➤ Ops Conference. International Air Transport Association. Vienna. <www.iata.org/events/Pages/ops-conference.aspx>.

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

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

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

APRIL 23–25 ➤ International Accident Investigation Forum. Air Accident Investigation Bureau of Singapore. Singapore. Steven Teo, <steven_teo@mot.gov.sg>, fax: (65) 6542-2394.

MAY 2–3 ➤ Air Transportation of Hazardous Materials. U.S. Department of Transportation, Transportation Safety Insititute. Anchorage, Alaska, U.S. Lisa Colasanti, <AviationTrainingEnrollment@dot.gov>, <1.usa.gov/VRFRYQ>, +1 405.954.7751. (Also JULY 30–AUG. 1, Oklahoma City, Oklahoma, U.S.)

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

MAY 14–16 ➤ Advanced Rotorcraft Accident Investigation. U.S. Department of Transportation, Transportation Safety Insititute. Okahoma City, Oklahoma, U.S. Lisa Colasanti, <AviationTrainingEnrollment@dot.gov>, <1.usa.gov/ZM138r>, +1 405.954.7751.

MAY 20–24 ➤ Unmanned Aircraft Systems. Southern California Safety Institute. Prague, Czech Republic. Denise Davalloo, <denise.davalloo@scsi-inc.com>, <www.scsi-inc.com/unmanned-aircraft-systems.php>, +1 310.940.0027, ext.104.

MAY 30–31 ➤ 2Gether 4Safety African Aviation Safety Seminar. AviAssist Foundation. Lusaka, Zambia. <events@aviassist.org>, <bit.ly/TtMkqD>, +44 (0)1326-340308.

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.

Landing Weight at 'Special' Airport

I note the article by Mark Lacagnina, "Double Whammy" [*ASW*, 9/12, p. 34] and the follow-up ["Speed Brake Warnings," *ASW*, 10/12, p. 12].

One aspect is briefly mentioned but receives no attention from anyone thereafter. It is noted that Jackson Hole is a "special airport," and that "the runway is usually slippery during the ski season and that high landing weights are common when operating at the airport." I am sure that great care is taken; however, would it not reduce the risk factor if it were arranged to arrive at this airport well below the maximum landing weight? We all know how quickly the landing margins can be eroded. I am assuming that the high landing weight is due to fuel and I have no doubt that there seem to be good reasons for operating in this way, but if that is the case, I do think that more attention should be given to this aspect.

Richard T. Slatter

AeroSafety World encourages comments from readers, and will assume that letters and e-mails are meant for publication unless otherwise stated. Correspondence is subject to editing for length and clarity.

Write to Frank Jackman, director of publications, Flight Safety Foundation, 801 N. Fairfax St., Suite 400, Alexandria, VA 22314-1774 USA, or e-mail <jackman@flightsafety.org>.

Engine (Identification) Failure?

I enjoy your magazine and appreciate the opportunity to read it at my place of employment. However, a recent article ["Double Whammy"] caught my attention.

Specifically, a causal factor is erroneously identified as a "sync-lock" mechanism on 757s/767s equipped with Pratt & Whitney engines. In fact, the airplane in question (and all American Airlines 757s) have the Rolls-Royce [RB211-]535 series engine.

The end note no. 54 in the NTSB report, page 21, states that P&W-equipped airplanes are the only Boeing planes that have this potential, but that note appears also to be erroneous. The photograph in the accompanying article clearly shows RR engines.

Darren Dresser

Mark Lacagnina replies: *The only mention of P&W engines in the Causal Factors article is in the statement: "The thrust-reverser system on 757s and 767s equipped with Pratt & Whitney engines has a 'sync-lock' mechanism that is intended to prevent the translating sleeves from extending accidentally due to a fault in the system."*

That statement is included in the capsulization of NTSB's findings about why the incident crew and other American Airlines pilots likely believed thrust reverser lock was not possible and thus were not prepared to handle it. The sync-lock mechanism was not identified by NTSB or by the article as a "causal factor" of the incident.

Safety News

Proactive Safety

The European Commission (EC) says it is proposing "ambitious and comprehensive" steps to develop a proactive, evidence-based aviation safety system, with an emphasis on comprehensive data-gathering.

"The current aviation regulatory system is primarily a reactive system relying on technological progress, the adoption of legislation overseen by effective regulatory authorities and detailed accident investigations leading to recommendations for safety improvements," the EC said in a December memo.

"However, whilst the ability to learn lessons from an accident is crucial, systems which are essentially reactive are showing their limits in being able to drive further improvements in the accident rate."

The answer, the EC said, is to gather and analyze all available aviation safety information.

The EC proposals include establishing "an appropriate environment to encourage aviation professionals to report safety-related information by protecting them from punishment except in cases of gross negligence" and ensuring that "the scope of mandatory reporting covers major potential risks and that the appropriate means to capture any safety threat are established [through] voluntary reporting schemes."

In addition, the proposals call for confidential safety information to be made available only to maintain or improve aviation safety. The EC added that its intent is to "diminish the negative effect that the use of such data by judicial authorities may have on aviation safety."

Other proposals call for improving the "quality and completeness" of occurrence reports, developing a better exchange of information among EC member states and improving data analysis at the European Union (EU) level so that it complements analysis performed at the national level.

The EC proposal must be approved by the European Parliament and the Council of member states before it takes effect.

EU transport ministers also called for an external aviation policy that will strengthen the competitiveness of the European aviation industry, in part by developing EU-level air transport agreements with neighboring countries.

Proposed Penalties

The U.S. Federal Aviation Administration (FAA) has proposed $633,000 in civil penalties against Trans States Airlines for its operation of two Embraer 145 regional jets on 3,660 passenger flights while the aircraft allegedly were out of compliance with Federal Aviation Regulations.

The FAA said that the airline operated two airplanes on 268 revenue passenger flights while the airplanes were equipped with improperly installed radio altimeter antenna cables. One aircraft was operated on 3,392 passenger flights with improperly installed electrical wiring in its fuel supply system, the FAA said.

In an unrelated case, the FAA proposed a $275,000 civil penalty against Pinnacle Airlines for allegedly operating a Bombardier CRJ on 11 flights after maintenance personnel failed to install a required part when they replaced an engine. The FAA said that, because Pinnacle is being reorganized under U.S. bankruptcy laws, the notice of proposed penalty is not a demand for payment.

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787 Grounding

The U.S. Federal Aviation Administration (FAA) on Jan. 16 grounded all U.S.-registered Boeing 787s, citing an in-flight "battery incident" earlier in the day on an All Nippon Airways (ANA) 787. The FAA said it would issue an emergency airworthiness directive to address the risk of battery fires in the airplanes.

Other civil aviation authorities worldwide immediately took similar action to keep 787s out of the skies. ANA and Japan Airlines had grounded their 787s prior to the FAA action.

"The FAA will work with the manufacturer and carriers to develop a corrective action plan to allow the U.S. 787 fleet to resume operations as quickly and safely as possible," the agency said. "Before further flight, operators of U.S.-registered Boeing 787 aircraft must demonstrate to the [FAA] that the batteries are safe."

Boeing Chairman, President and CEO Jim McNerney said the company is "committed to supporting the FAA and finding answers as quickly as possible. …We are confident the 787 is safe, and we stand behind its overall integrity."

Published reports said the in-flight incident involved warning lights indicating a battery problem in a 787 on a domestic flight in Japan and quoted Yoshitomo Tamaki, director general of the Japan Transport Safety Board, as saying there was a bulge in the metal case that housed the battery.

The grounding came five days after the FAA announced a review of the 787's critical systems, especially its electrical systems; that action came in the wake of a battery fire in a Japan Airlines 787 parked at Logan International Airport in Boston.

Fifty 787s had been in service worldwide.

SMS Start-Up

The U.S. Federal Aviation Administration (FAA) should consider asking Congress to provide additional protections for data gathered through safety management systems (SMS), a U.S. government watchdog agency says.

The Government Accountability Office (GAO) said in a December report on the FAA's progress in SMS implementation — both within the agency and throughout the aviation industry — that data protection concerns "could prevent aviation stakeholders from fully embracing SMS implementation, thus hindering its effectiveness.

"Without assurance of protection from state [freedom of information] laws, some aviation stakeholders may choose to collect only the bare minimum of safety-related data or may choose to limit the extent to which collected information is shared among aviation stakeholders."

In addition, GAO said, "the ability of FAA to identify safety risks, develop mitigation strategies and measure outcomes is hindered by limited access to complete and meaningful data."

GAO said that the FAA and the aviation industry are making progress in SMS implementation, although it will take years to accomplish the "cultural and procedural shift" in FAA internal operations and in the agency's oversight of airlines, airports and other aviation stakeholders.

"Going forward, if FAA is to attain the full benefits of SMS, it will be important for the agency to remain committed to fully implementing SMS across its business lines," GAO said. "FAA has taken a number of steps that align with practices we identified as important to successful project planning and implementation but has not addressed or has only partially addressed other key practices … [that] are important for large-scale transformative projects such as SMS."

GAO's other recommendations included calls for development of a data-collection system to be used in evaluating whether SMS is meeting designated goals and implementation of a system of evaluating employee performance as related to SMS.

GAO also recommended developing a system to track SMS implementation and conducting a workforce analysis to identify employee skills and strategies for addressing SMS-related skills gaps.

Flight Simulation Goals

The Australian Civil Aviation Safety Authority (CASA), urging the increased use of flight simulators throughout the aviation industry, has established six related goals for flight simulation over the next two years.

The goals include adopting the International Civil Aviation Organization framework for simulator classification, mandating that simulators be used for training and checking of high-risk emergency procedures in some aircraft types, and encouraging operators to upgrade and maintain their simulators.

"Technological advances have seen significant improvement in the fidelity of flight simulation devices at all levels," CASA said in its *Flight Simulation Operational Plan 2012–2014*. "Flight simulators provide more in-depth training, particularly in the practice of emergency and abnormal operations, than can be accomplished in aircraft."

CASA said that Australia currently has 34 full-flight simulators; five flight training devices, which do not have motion; and 91 instrument flight trainers.

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Workplace Safety

Workplace safety standards for flight attendants should be enforced by the U.S. Occupational Safety and Health Administration (OSHA), the Federal Aviation Administration (FAA) said in proposing a regulation to expand OSHA's authority.

"While the FAA's aviation safety regulations take precedence, the agency is proposing that OSHA be able to enforce certain occupational safety and health standards currently not covered by FAA oversight," the FAA said.

Under the proposal, flight attendants could report workplace injury and illness complaints to OSHA, which would have the authority to investigate. Workplace issues could include exposure to noise and disease-causing microorganisms, the FAA said.

"The policy … [would] not only enhance the health and safety of flight attendants by connecting them directly with OSHA but will by extension improve the flying experience of millions of airline passengers," said U.S. Labor Secretary Hilda L. Solis.

A final policy will be announced after authorities have reviewed public comments on the proposed regulation. The comment period was scheduled to end Jan. 22.

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Engine Warning

Operators of aircraft with Rolls-Royce RB211-524 engines have been warned of a potential for degradation of the engines' intermediate-pressure turbine blade interlocking shrouds, which, if not corrected, could result in the cracking and loss of turbine blades, the Australian Transport Safety Bureau (ATSB) says.

The ATSB cited the May 9, 2011, malfunction of an engine on a Qantas Airways Boeing 747-400 during a flight from Sydney, New South Wales, Australia, to Singapore. The crew observed abnormal indications from the no. 4 engine during a climb from 36,000 ft to 38,000 ft. The crew shut down the engine, continued the flight to Singapore and landed without further incident.

The ATSB investigation traced the problem to the "failure and separation of a single intermediate-pressure turbine blade … [which] fractured following the initiation and growth of a fatigue crack from an origin area near the blade inner root platform."

The cause of the blade failure was not immediately identified, but the manufacturer's post-accident analysis revealed that "wear and loss of material from the turbine blade outer interlocking shrouds had reduced the rigidity and damping effects of the shroud and may have contributed to the high-cycle fatigue cracking and failure."

The manufacturer's analysis was continuing.

The ATSB said that Rolls-Royce issued non-modification service bulletin 72-G739 in October 2011, directing operators to inspect the intermediate-pressure turbine blades in the affected engines to determine if any shroud interlock material was missing. Qantas had completed the required inspections and found no instances of excessive wear, the ATSB said.

The agency said three similar events have been reported in RB211-524 history and the probability of further events is "extremely low." Blade separation probably will result in engine malfunctions and an in-flight engine shutdown, but risks to the safety of continued flight are minor, the ATSB said.

Information Sharing

Flight Safety Foundation (FSF) and the International Civil Aviation Organization (ICAO) have begun a new cooperative effort to promote and share aviation safety information and metrics.

The new worldwide initiative is designed to support ICAO guidance for safety management systems, which calls for increased monitoring, analysis and reporting of safety data.

"The establishment of this framework for enhanced cooperation with FSF is an important step in helping us achieve the highest levels of aviation safety worldwide," said Roberto Kobe González, president of the ICAO Council. "Aviation safety knows no borders, and these types of collaborative data sharing and risk mitigation efforts are essential to help states and industry address safety risks before they lead to a serious incident or accident."

The memorandum of cooperation calls for ICAO and the Foundation to work together to encourage compliance with ICAO standards and recommended practices and related guidance material.

The memorandum also "promotes joint activities between the organizations in the areas of data sharing and analysis, training and technical assistance," according to the announcement of the agreement. "The joint analyses developed will facilitate the harmonization of proactive and predictive safety metrics and the promotion of a just safety culture globally."

William R. Voss, then FSF president and CEO, noting that some U.S. air carriers and the U.S. Federal Aviation Administration already operate under cooperative data-sharing agreements, said the new cooperative agreement would help other countries "establish models that are suited to their unique needs and constraints."

Regional forums will be convened soon to aid in establishing information-sharing goals.

In Other News …

Michael Huerta was sworn in as administrator of the U.S. Federal Aviation Administration in early January, after serving as acting administrator for more than one year. … The European Union and Eurocontrol have agreed to establish a new framework for cooperation in implementing the **Single European Sky** program. … The European Commission has removed all air carriers certified in **Mauritania** from its list of those banned from operating in the European Union. The December revision added to the list air carriers certified in **Eritrea**.

Compiled and edited by Linda Werfelman.

Outmaneuvered AIRFLOW

BY WAYNE ROSENKRANS

U.S. wake vortex science safely updates approach and departure concepts essential to NextGen capacity gains.

Today's portable sensors and data-analysis techniques enable scientists worldwide to visualize dimensions, measure velocities and track positions of wake vortices generated by specific variants of large commercial jets. That's a far cry from igniting elevated smoke pots for low-level overflights in the early 1970s, says Steven Lang, director of the U.S. Center for Air Traffic Systems and Operations at the John A. Volpe National Transportation Systems Center.

"Wake turbulence is an inevitable consequence of flight — aircraft lift generation," Lang said during a Web briefing for news media in November 2012. "Wake turbulence separations in a sense reduce capacity at airports because you have to add spacing behind the larger aircraft for safety mitigation."

The evolving precision partly explains how several redesigns of air traffic procedures have been accomplished recently, he said, summarizing a paper published in October.[1] In the United States, Volpe and the Federal Aviation Administration (FAA), often in partnership with European counterparts, have used field research to build safety cases verifying that risks in proposed changes to air traffic control (ATC) procedures are acceptable.

Essentially, the National Airspace System has begun to see the results of a decision in 2001 that set near-term, mid-term and long-term goals "to focus on operationally feasible solutions rather than just looking at wake science as a solution," Lang said. Flexibility was added, too, to explore solutions to practical problems other than encounters with heavy-jet wake vortices (see "Airbus Measures Relative Wake Vortex Characteristics," p. 14). Lang also credited clear-cut, stakeholder advisory processes launched then under the FAA's safety management system.

In the past 30 years, various sensors and techniques incrementally improved study of wake generation, transport and decay. The most radical change came from pulsed lidar, which Lang described as "a radar-laser type of device that actually measures the vortex as it's generated from the aircraft [and] shed from the aircraft. …

The entire safety region that we have to be concerned with is now measurable by pulsed lidar."

Cooperation among global networks of scientists also has accelerated the development of practical solutions for wake vortex mitigation. Another factor has been bringing together pilots, airline safety specialists, air traffic controllers, the science community and regulators. "Before that, it was purely a science effort," he recalled. "The scientists decided what they wanted to study, what they wanted to research and there was little involvement from the people that actually had to fly or operate the system."

The ATC innovations discussed fall into two types: closely spaced parallel runway operations and single-runway in-trail wake separation operations. The FAA defines closely spaced parallel runways as runways that have less than 2,500 ft (762 m) between their centerlines.

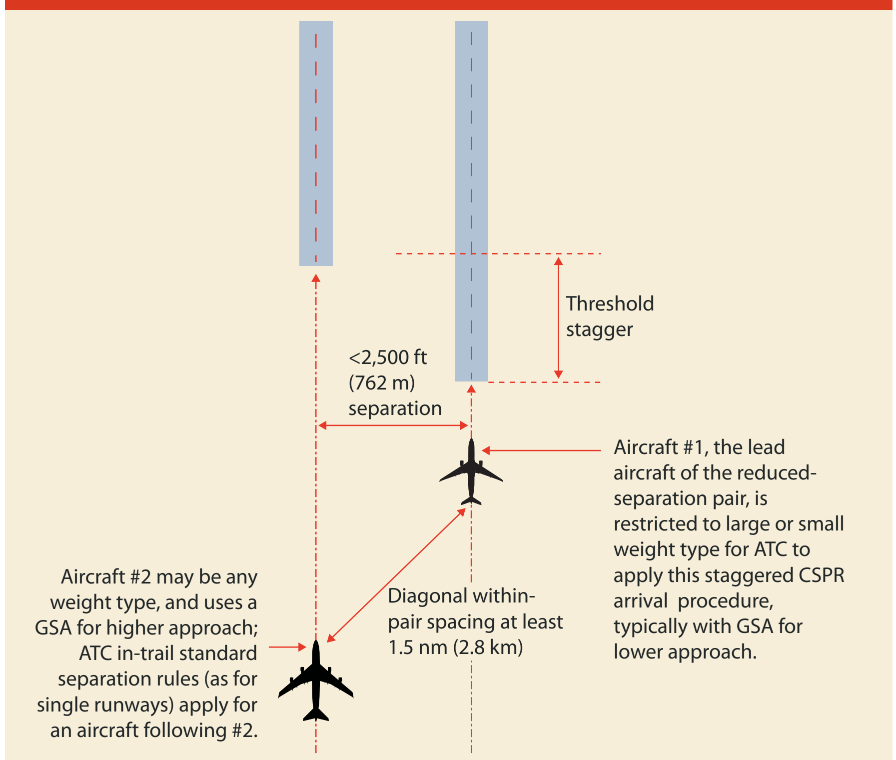
In planning the Next Generation Air Transportation System (NextGen), increased system capacity will come partly from satellite-based communication, navigation and surveillance advances that enable aircraft to be operated with *minimum* spacing needed for safety. But Lang said, "All those things are wonderful, but the last piece … is the *maximum* spacing needed, which is wake turbulence separation. … It's good that you did all of that navigation improvement and surveillance improvement and everything else that goes along with that, but if you don't solve the wake problem, you can't put aircraft closer together. … So it's very important that wake turbulence gets solved in time for NextGen. … Unless wake turbulence is addressed, you're stuck with what you have. … Many concepts would not realize their full potential."

For example, one of the long-term ATC standards within NextGen will be dynamic pairwise separation. "That's where the aircraft weight configuration, the weather condition … the time of arrival, the route of flight are all taken into account and then [ATC will] develop the separation standard for that specific scenario," he said. "So one day, you might be 4 nm [7.4 km] behind an aircraft; the next day you might be 3 nm [5.6 km] behind the aircraft because of the configuration, the weight and the [meteorological] conditions. … So it's a system that … delivers a spacing, a yea-or-nay spacing, to the controller that [says] 'Yes, you can do it,' or 'No, you cannot do it.'"

With that still on the far horizon, FAA and Volpe also revisited procedures that had been based on now-outdated wake vortex measurements. One effort proved with safety-case data that positioning a smaller aircraft at least 1.5 nm (2.8 km) from any larger aircraft during their arrivals to closely spaced parallel runways could be done safely (Figure 1). Safety cases now are being prepared to add two more airports to the eight for which such runway pairings were authorized as of October 2012.

"By using the parallel runways, you actually reduce the risk of a wake encounter for the parallel-runway

Staggered ILS Approaches to Closely Spaced Parallel Runways



ATC = air traffic control
CSPR = closely spaced parallel runways
GSA = glide slope angle
ILS = instrument landing system
IMC = instrument meteorological conditions

Note: This ATC procedure during IMC has been implemented at eight major U.S. airports, enabling controllers to safely apply this minimum 1.5-nm within-pair spacing regardless of wake vortices or wind conditions. GSAs vary from 2.75 to 3.1 degrees.

Source: Steven R. Lang and U.S. Federal Aviation Administration Air Traffic Organization, "1.5-Nautical Mile Dependent Approaches to Parallel Runways Spaced Less Than 2,500 Feet Apart," Policy JO 7110.308 CHG 3, effective Oct. 30, 2012.

Figure 1

Airbus Measures Relative Wake Vortex Characteristics

Wake vortex encounters severe enough to threaten an upset of one large commercial jet flying behind another have been rare for simple reasons, suggest recent presentations of data from experiments by Airbus. Benign encounters are very common, however, says Claude Lelaie, senior vice president and product safety officer, Airbus, and a former Airbus test pilot and airline captain.

"The probability to have a severe encounter is in fact very low," Lelaie said. "Why? Because you have to enter the vortex, a very small tube … about 6 m [20 ft] diameter. You have to enter exactly in the center, and you have to enter with the proper [10-degree] angle. … If you have turbulence and so on, everything disappears. … Even when trying to have a strong encounter every time, we did not manage to have a strong encounter every time."

Nevertheless, the Airbus analysis also has concluded that "there is a possibility to have a severe encounter in flight where there is a type of generating aircraft at a distance [more than] the standard minimum 5 nm [9 km] separation and with 1,000 ft vertical separation," he said.

Airbus presented these data and conclusions to the Wake Vortex Study Group of the International Civil Aviation Organization (ICAO), which has been updating recommendations for flight crews and air traffic controllers. Lelaie also briefed Flight Safety Foundation's International Air Safety Seminar in October 2012 in Santiago, Chile.

The 200 encounters Airbus studied were carefully orchestrated missions — at a cruise altitude of about 35,000 ft — to insert a follower aircraft into the center of the strongest/worst wake vortices/contrails to induce effects associated with in-flight upset, Lelaie said. The missions involved precisely positioning the generator-follower pairs in ideal, repeatable calm-weather conditions. An Airbus A380 with an adjacent A340-600 or a Boeing 747-400 on a parallel flight path were used as the wake vortex–generators. The A340-600 and an Airbus A318 took turns as follower aircraft. He described one test protocol.

"Two aircraft were flying side by side [into the wind], the A380 and the reference aircraft, which was either a 340-600 or the 747," Lelaie said. "An A318 was flying behind and below at a distance between 5 and 15 nm, and we had above a Falcon 20 from the DLR [German Aerospace Center] with an onboard lidar."[1] A 10-degree entry angle was considered the most critical case. "If you are almost parallel, you will be ejected from the vortex," he said. "If you cross perpendicularly, [the encounter] will be very short and almost nothing will happen."

Some findings ran counter to conventional assumptions about wake vortex effects on the existing design of reduced vertical separation minimums operations, notably what he termed an incorrect assumption that wake vortices from a 747 do not descend more than 800 or 900 ft.

Airline pilot knowledge and training to correct an unexpected roll remain sufficient mitigations for wake vortex encounters involving one large commercial jet behind another, he noted. "In the vortex … you can get strong vertical acceleration, positive or negative," Lelaie said. "For the vortex encounter, what we clearly recommend [to Airbus flight crews] is please do nothing. Release controls and do nothing, and once you have passed the vortex, nothing will happen. … The roll [response] is just normal roll control." International guidance on airplane upset prevention and recovery has been published by government and industry.[2]

One part of the Airbus study focused on measuring the rate of descent of wake vortices from each generator aircraft. Another focused on effects on the follower aircraft. The most important effect was roll acceleration, the direct indicator of vortex strength (Table 1, p. 16). Less interesting to researchers in practical terms were altitude loss, bank angle, vertical acceleration and roll rate, he said. Scientific instruments and video cameras also documented the bank, buffeting and the pilot's correction of uncommanded bank.

Regarding the rates of descent of vortices while flying at Mach 0.85, there was no difference between the A380 and 747-400, Lelaie said. He noted, "There was a slight difference with the A340-600 flying at Mach 0.82, but at the end of the day, all vortices [had descended] 1,000 feet at around 12, 14, 15 nm [22, 26, 28 km]. … This showed clearly that … at 15 nm behind any of these aircraft, you can find a vortex. … The [strength/roll rate acceleration] decrease with the distance is rather slow. At 5 nm, you have a good encounter; at 15 [nm] you have decreased [strength of] maybe 30 to 40 percent, it's not a lot."

As expected, lateral-acceleration maximum load factor and minimum load factor were significantly different in the forces recorded at the back of the follower-aircraft fuselage versus those felt by occupants because the airplane's turning point actually is in front of the aircraft. "These load factors are not what the passenger or what the pilot can feel," he said. "[They're] much higher." Nevertheless, occupants may feel strong lateral acceleration on the order of 2.5 g, 2.5 times normal gravitational acceleration. "Even at 18 nm [33 km], we have with all aircraft 2 g, again at the back," he added, and data in some cases showed small negative-g values.

"One which is interesting is this one, 747 and A318," he said. "Look at that: –0.7 [g]," he said. "In the middle of the fuselage it would have been –0.4 or –0.3 [g] but the [unrestrained person] in that seat will bump on the ceiling." Cases of the A380 followed by the A318 and the A380 followed by the

Continued on p. 16

aircraft versus going in-trail," Lang said, explaining that "by placing an aircraft in a staggered position, it has less risk of a wake encounter than if you put it single file to the same runway."

Data collection and building of safety cases for arrivals positioned FAA/Volpe to pursue similar concepts to make simultaneous departures of disparate-size aircraft on closely spaced parallel runways feasible mainly by taking into account the effect of a favorable wind direction and velocity through a new *wake turbulence mitigation for departure* (WTMD) system.

To mitigate the risk of a wake encounter, "physics tells you that if [one aircraft] is a heavy jet, you would have to stop this [other, lighter] aircraft from departing for three minutes in this geometry (Figure 2) or two minutes if this [runway end is staggered by] less than 500 ft [152 m]," he said. "If the wind is blowing this direction, this wake for the most part cannot transport against the wind and get over to that [parallel] runway. … The controllers have a system in the control tower at … three airports — going live in January at Houston and then in San Francisco and Memphis." The system advises the controller with a red light/green light display when the required conditions exist.

When fully available in Houston, "we envision [WTMD] will increase their capacity significantly [by] three, maybe four departures an hour," Lang added.

The third focus of practical solutions derived from advanced measurement has been single-runway solutions. Essentially, this program recategorizes aircraft from their legacy ATC-spacing categories, based on wide ranges of maximum takeoff weights and wingspans, to a new set of six categories based on different parameters. Under the legacy system, both a Boeing 747 that weighs about 900,000 lb (408,233 kg) and a 767 that weighs about 320,000 lb (147,417 kg) were in the *heavy* category B.

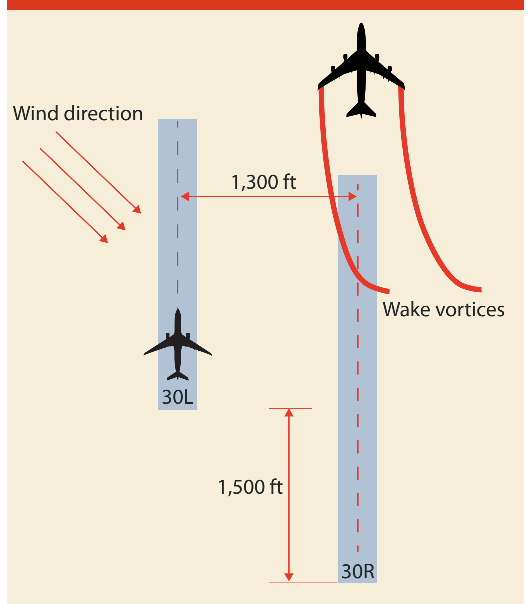
"These two aircraft have to be 4 nm apart because they are in that same category, regardless of [which] is in front, [and that] doesn't make a lot of sense," he said. "The [767] behind [the 747] probably needed 4 nm but the 747 following [the 767] did not need 4 nm." The resulting program, implemented in Memphis in November, is called Wake RECAT phase 1 and includes additional safety buffers for the lightest aircraft types.[3] Preliminary reports estimate at least a 10-percent capacity boost, and possibly 20 percent.

"In Memphis, the one observation that FedEx has made is they used to have backups at the runway both for arrivals and departures, and now they find themselves 'drying up,' as they call it," he said. "Recategorization has now made it [so] that there is no queue, and now they're having to rethink how they get the aircraft out of the ramp areas, out to the runway to be able to take advantage of the empty runway." This system operates independently of meteorological conditions.

The main reason that other airports cannot implement Wake RECAT phase 1 in the same time frame has involved local variations in ATC automation systems, he said. Wake RECAT phase 2, also under way, supports ATC static pairwise separation — that is, separation based on airport-specific categories of aircraft. As noted, the long-term move to ATC dynamic pairwise separation will be supported in weather-based phase 3. Lang said that such changes typically take time to generate predictable and measurable capacity benefits while the local ATC personnel become accustomed to new procedures.

Related applications of wake vortex data have enabled the FAA to divide three variants of the 757 within U.S. ATC separation and in separation standards of the International Civil Aviation Organization. Another example he cited was Volpe's wake data collection for Boeing during testing of the 747-800 for standards development.

Concept of Wake Turbulence Mitigation for Departures



STL = Lambert–St. Louis International Airport
IAH = Houston Intercontinental Airport
MEM = Memphis International Airport
SFO = San Francisco International Airport

Note: An operational demonstration at three U.S. airports with closely spaced parallel runways (IAH, MEM and SFO; not including STL used here for illustration) permits upwind-runway departures to occur simultaneously with downwind-runway departures that meet specified real-time wind criteria with conditions of approximately 3 mi (5 km) visibility and a minimum 1,000 ft ceiling.

Source: Steven R. Lang, John A. Volpe National Transportation Systems Center, U.S. Department of Transportation

Figure 2

Airbus Measures Relative Wake Vortex Characteristics (continued)

A340-600 also showed that "you can have something quite strong in terms of g," he said.

Lelaie also pointed to ongoing work by a Eurocontrol–Delft University of Technology study, looking at the correlation between actual wake vortex encounters and mapped hot spots, areas where encounters were predicted based on European air traffic data, as a promising path to further risk reduction.

— WR

Notes

1. *Lidar* means light detection and ranging, and pulsed lidar combines laser and radar sensor technology to visualize and measure wake vortex characteristics.
2. One such resource that discusses wake turbulence is the *Airplane Upset Recovery Training Aid, Revision 2* (November 2008) available at <flightsafety.org/archives-and-resources/airplane-upset-recovery-training-aid>.

Wake Vortex-Induced Main Upsets for Selected Cases in Encounters Tested by Airbus

	Vertical Separation <1,000 ft					Vertical Separation >1,000 ft		
Generator airplane	A380	A340-600	B747-400	B747-400	A380	A380	B747-400	A380
Follower airplane	A318	A318	A318	A318	A340-600	A318	A318	A340-600
Horizontal separation (nm)	12.2	12.3	5.32	14.9	13.5	18.1	15.8	19.3
Vertical separation (ft)	838	608	432	832	851	1,015	1,038	1,168
Roll acceleration (deg/s^2)	49	75	69	146	24	68	109	12
Roll rate (deg/s)	24	35	18	36	5	20	31	7
Bank (degrees)	46	38	35	31	10	29	34	10

deg/sec^2 = degrees per second per second
deg/sec = degrees per second

Note:
The A318, A340-600 and A380 are Airbus aircraft types; the 747-400 is a Boeing aircraft type. Airbus also reported the lateral and vertical accelerations of the follower aircraft; these are not shown.

Source: Claude Lelaie

Table 1

Rethinking wake turbulence risk has involved more than the research capability. For example, meteorological and short-term wind nowcasting have improved significantly. "One thing FAA is has been pursuing, and we have been supporting, is getting wind [data] off the aircraft [in real time]," Lang said. "Currently, that's probably the best sensor in existence [but so far] the system does not receive wind off of the aircraft."

Volpe also has been working with FAA's Aviation Safety Information Analysis and Sharing program and the FAA-industry Commercial Aviation Safety Team in seeking to eventually acquire aggregated, de-identified data that might better link the scientists to airline experiences with wake encounters.

Notes

1. Tittsworth, Jeffrey A.; Lang, Steven R.; Johnson, Edward J.; Barnes, Stephen. "Federal Aviation Administration Wake Turbulence Program — Recent Highlights." Paper presented to Air Traffic Control Association Annual Conference and Exhibition, Oct. 1–3, 2012. <ntl.bts.gov/lib/45000/45900/45912/Lang__Wake_Turbulence_Program.pdf>
2. FAA. "1.5-Nautical Mile Dependent Approaches to Parallel Runways Spaced Less Than 2,500 Feet Apart." Air Traffic Organization Policy JO 7110.308 CHG 3, effective Oct. 30, 2012.
3. FAA. "Guidance for the Implementation of Wake Turbulence Recategorization Separation Standards at Memphis International Airport." Air Traffic Organization Policy N JO 7110.608, effective Nov. 1, 2012.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The year 2012 set records globally for the fewest major accidents involving commercial jets and commercial turboprops. The decreasing trend in the commercial jet accident rate was extended. The 2011 record rate, 0.28 major accidents[1] per million departures for commercial jets, was reduced by 50 percent to a record low of 0.14. For the second year in a row, there were no commercial jet upset aircraft accidents.

But the increase in controlled flight into terrain (CFIT) accidents continued. Three of the seven commercial jet accidents were CFIT. Commercial turboprops also set a record low for the number of major accidents, although CFIT again dominated their fatality numbers. Business jets had 13 major accidents, slightly above their 12-year average.

There are now more than 22,000 commercial jets in the world. Of these, approximately

CFIT claimed the lives of all 127 occupants of a Boeing 737 in a crash on approach to Islamabad, Pakistan.

Accident numbers and rates decreased further in 2012, but CFIT is still a concern.

CFIT's Unwelcome Return

BY JAMES M. BURIN

5 percent are Eastern-built. The world's commercial turboprop fleet is 20 percent Eastern-built. About 9 percent of the total commercial jet fleet is inactive, including almost 50 percent of the Eastern-built aircraft. Fifteen percent of the 6,012 turboprops are inactive. For the third year in a row, there were inactive business jets, including 3 percent of the inventory.

The commercial jet inventory grew about 1 percent from the 2011 numbers, while the commercial turboprop inventory decreased 2 percent. The business jet inventory continued to lead in growth, with the current inventory of 17,642 aircraft representing a 2.5 percent increase from the previous year.

Seven major accidents involving scheduled and unscheduled passenger and cargo operations, for Western- and Eastern-built commercial jets, occurred in 2012 (Table 1). Six of the seven were approach and landing accidents. Three of the seven were CFIT, and there were two runway excursion accidents.

Figure 1 shows the total number of major accidents, including those involving Eastern-built aircraft, for commercial jets during the past 12 years. The overall number of accidents in 2012 was down dramatically. Even though only about 3 percent of the active commercial jet fleet is Eastern-built, they accounted for 43 percent of the major accidents.

Figure 2 shows the commercial jet major accident rate and the five-year running average. This rate is only for Western-built jets because, even though we know the number of major accidents for Eastern-built jets, we do not have reliable worldwide exposure data (hours flown or departures) to calculate valid rates for them. After a decade of an almost constant major accident rate for commercial jets, we now see a trend of improvement.

Business jets had 13 major accidents in 2012 (Table 2, p. 20). This is slightly greater than their 12-year average of 10.5. Calculating accident rates for business jets is difficult due to the lack of reliable exposure data. One rate that can be calculated is the number of major accidents per 1,000 aircraft. Using that metric shows the

Major Accidents, Worldwide Commercial Jets, 2012

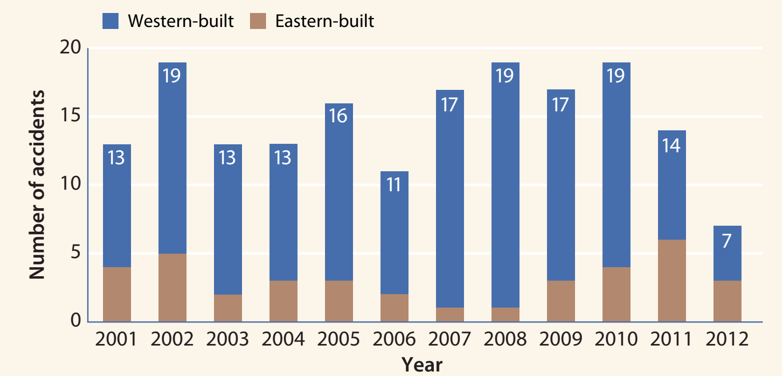
Date	Operator	Aircraft	Location	Phase	Fatal	
April 20	Bhoja Airlines	737	Islamabad, Pakistan	Approach	127	● CFIT
May 9	Sukhoi	Su-100	Mount Salak, Indonesia	En route	45	● CFIT
June 2	Allied Air	727	Accra, Ghana	Landing	0	● Runway excursion
June 3	Dana Air	MD-83	Lagos, Nigeria	Approach	153	
Nov. 30	Aero Service	IL-76	Brazzaville, Congo	Landing	6	
Dec. 25	Air Bagan	F-100	Heho, Myanmar	Landing	1	● CFIT
Dec. 29	Red Wings Airlines	Tu-204	Moscow, Russia	Landing	5	● Runway excursion

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

Source: Ascend

Table 1

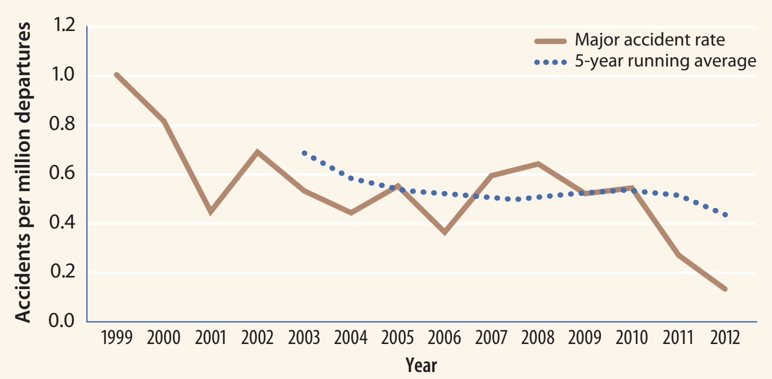
Commercial Jet Major Accidents, 2001–2012



Source: Ascend

Figure 1

Western-Built Commercial Jet Major Accident Rates, 1999–2012



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

Source: Ascend

Figure 2

improvement in the business jet accident rate over the past eight years (Figure 3).

The 17 major accidents involving Western- and Eastern-built commercial turboprops with more than 14 passenger seats in 2012 (Table 3) were well below the 12-year average of 25.9. The past 12 years of turboprop accident numbers show the record low in 2012 (Figure 4). Unfortunately, CFIT continues to dominate the fatality numbers for commercial turboprops. In 2012, four of the 17 major accidents (24 percent) were CFIT. Over the past six years, 28 percent (more than one in four) of the commercial turboprop major accidents have been CFIT.

CFIT, approach and landing, and upset aircraft accidents continue to account for the majority of accidents and cause the majority of fatalities in commercial aviation. There were only seven commercial jet accidents in 2012, but six of the seven (86 percent) were approach and landing accidents, and three of the seven (43 percent) were CFIT.

The upward trend of CFIT accidents for all commercial jets since 2009 (Figure 5) is disturbing, particularly because more than 95 percent of commercial jets have been equipped with terrain awareness and warning systems (TAWS) since 2007. During the past six years, there have been 37 commercial aircraft CFIT accidents (14 jet, 23 turboprop). In the past two years, more than 50 percent of the commercial jet fatalities have been caused by CFIT accidents.

In 2006, upset aircraft accidents took over from CFIT as the leading killer in commercial aviation. Over the past two years, commercial jets have suffered six CFIT accidents and no upset aircraft accidents. Because of this, CFIT is about to regain its title as the leading killer.

But until then, upset aircraft accidents still are the leading killer

Major Accidents, Worldwide Business Jets, 2012

Date	Operator	Aircraft	Location	Phase	Fatal
Feb. 2	Extrapoint	Lear 35	Pueblo, Colorado, U.S.	Takeoff	0
Feb. 12	Trident Aviation Svcs.	Gulfstream IV	Bakavu-Kavumu, DRC	Landing	3
March 1	Asia Today	Citation X	Egelsbach, Germany	Approach	5
March 15	Private	Citation I SP	Franklin-Macon, North Carolina, U.S.	Landing	5
June 18	Triple C Development	Beech 400	Atlanta, Georgia, U.S.	Landing	0
July 13	Universal Jet Aviation	Gulfstream IV	Le Castellet, France	Landing	3
Aug. 2	Airnor	Citation 500	Santiago de Compostela, Spain	Approach	2
Sept. 15	Private	Lear 24	Bornholm, Denmark	Approach	0
Sept. 18	Dewberry Air	Beech 400	Macon, Georgia, U.S.	Landing	0
Nov. 11	Tropic Air Taxi Aero	Citation 525	São Paulo, Brazil	Landing	0
Nov. 17	U.S. Customs	Citation 550	Greenwood, South Carolina, U.S.	Landing	0
Dec. 9	Starwood Management	Lear 25	Iturbide, Mexico	En route	7
Dec. 21	U.S. Customs	Citation 550	Oklahoma City, Oklahoma, U.S.	Landing	0

Source: Ascend

Table 2

Major Accidents, Worldwide Commercial Turboprops, 2012

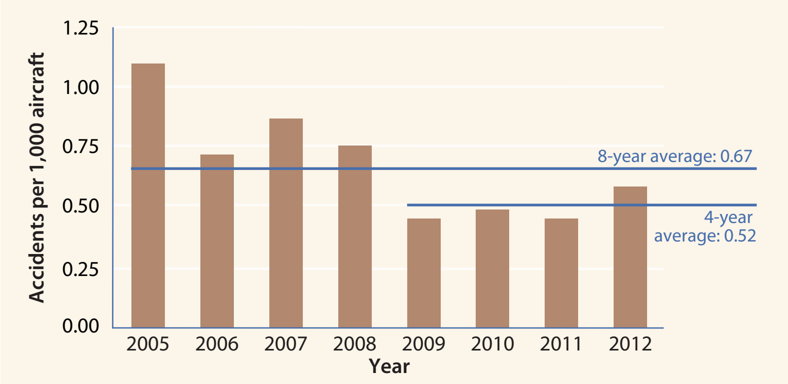
Date	Operator	Aircraft	Location	Phase	Fatal	
Jan. 30	TRACEP	AN-28	Namoya, DRC	En route	3	●
April 2	Utair	ATR-72	Tyumen, Russia	Takeoff	31	
April 9	Air Tanzania	DHC-8	Kigoma, Tanzania	Takeoff	0	
April 28	Jubba Airways	AN-24	Galkayo, Somalia	Landing	0	
May 14	Agni Air	DO-228	Jomsom, Nepal	Approach	15	●
June 6	Air Class Líneas Aéreas	SW Metro III	Montevideo, Uruguay	Climb	2	
June 10	Ukrainska Shkola Pilotov	LET-410	Borodyanka, Ukraine	En route	5	
June 20	ITAB	Gulfstream I	Pweto, DRC	Landing	0	
Aug. 19	ALFA Airlines	AN-24	Talodi, Sudan	Approach	32	●
Aug. 22	Mombassa Air Safari	LET-410	Ngeredi, Kenya	Takeoff	4	
Sept. 12	Petropavlovsk-Kamchatsky Air Enterprise	AN-28	Palana, Russia	Approach	10	●
Sept. 28	Sita Air	DO-228	Kathmandu, Nepal	Climb	19	
Oct. 7	Azza Transport	AN-12	Khartoum, Sudan	En route	13	
Oct. 19	Air Mark Aviation	AN-12	Shindand, Afghanistan	Landing	0	
Nov. 27	Inter Iles Air	EMB-120	Moroni, Comoros	Climb	0	
Dec. 17	Amazon Sky	AN-26	Tomas, Peru	En route	4	
Dec. 22	Perimeter Aviation	Metro III	Sanikiluaq, Canada	Approach	1	

● Controlled flight into terrain (CFIT) accident

Source: Ascend

Table 3

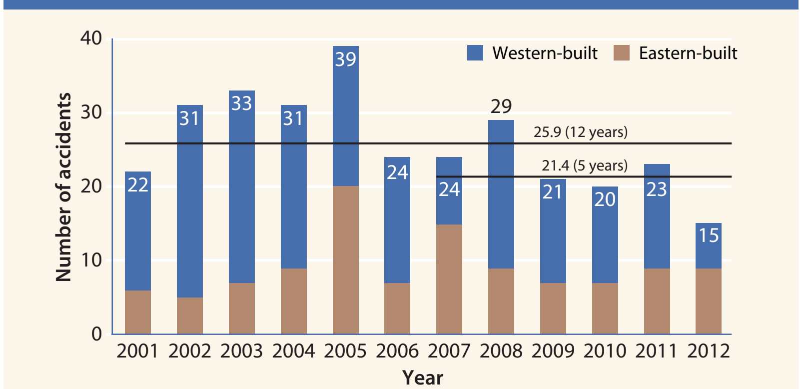
Major Accidents, Business Jets, 2005–2012



Source: Ascend

Figure 3

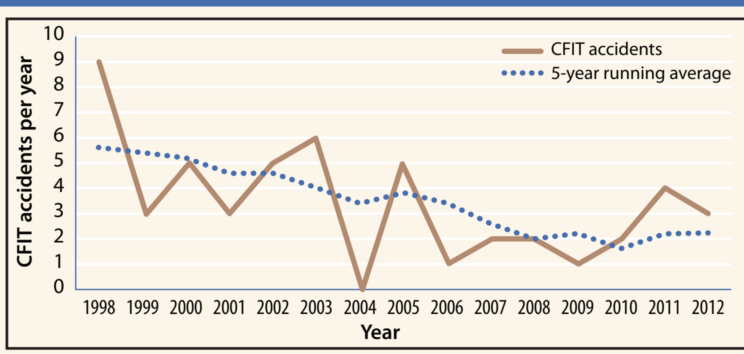
Major Accidents, Worldwide Commercial Turboprops, 2001–2012



Source: Ascend

Figure 4

CFIT Accidents, Worldwide Commercial Jets, 1998–2012



CFIT = controlled flight into terrain

Source: Flight Safety Foundation

Figure 5

in commercial aviation. In keeping with the terminology in the 1998 *Airplane Upset Recovery Training Aid*,[2] an aircraft is considered upset if one of the following conditions is met: pitch attitude greater than 25 degrees nose up; pitch attitude greater than 10 degrees nose down; bank angle greater than 45 degrees; within the previous parameters, but flying at airspeeds inappropriate for conditions. "Upset aircraft" accidents include accidents involving related terms such as loss of control, lack of control, unusual attitude, stall, extended envelope and advanced maneuvering.

An upset aircraft accident is one in which the aircraft is upset and unintentionally flown into a position from which the crew is unable to recover due to either aircrew, aircraft or environmental factors, or a combination of these. Another term used to describe these accidents is "loss of control." This is a somewhat misleading term, because in 48 percent of the "loss of control" accidents over the past 10 years, there was no literal loss of control — the aircraft responded correctly to all control inputs. However, in 100 percent of the currently classified "loss of control" accidents, the aircraft was upset. There currently are more than 15 international efforts under way to address airplane upset prevention and recovery. The lack of any commercial jet upset accidents over the past two years indicates that these efforts may be seeing some success.

James M. Burin was the director of technical programs at Flight Safety Foundation.

Notes

1. The term *major accident* was created by Flight Safety Foundation in 2006. It refers to an accident in which any of three conditions is met: The aircraft is considered destroyed, as calculated by dividing the estimated cost of repairs to the hypothetical value of the aircraft had it been brand new at the time of the accident; or there were multiple fatalities to the aircraft occupants; or there was one fatality and the aircraft was substantially damaged.

   This criterion ensures that the categorization of an accident is not determined by an aircraft's age or its insurance coverage.

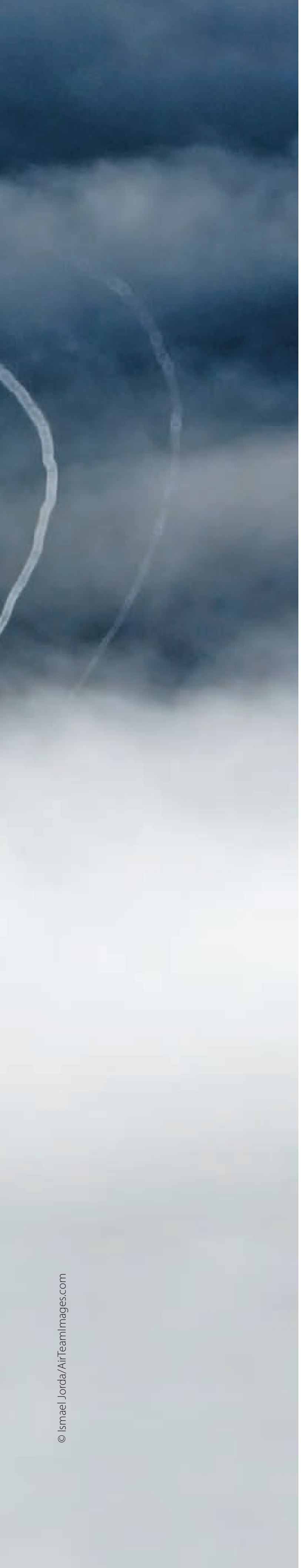
2. <flightsafety.org/archives-and-resources/airplane-upset-recovery-training-aid>.

Failure to Mitigate

BY J. MARTIN SMITH, DAVID W. JAMIESON AND WILLIAM F. CURTIS

Studying the psychology of decision making during unstable approaches and why go-around policies are ineffective.

The Flight Safety Foundation has analyzed the past 16 years of aircraft accident data and found that the most common type of accident is the runway excursion, which accounts for 33 percent of *all* aircraft accidents.[1] The highest risk factor for runway excursions is the unstable approach.[2] Unstable approaches occur on 3.5 to 4.0 percent of all approaches, but only 3 percent of these unstable approaches result in a go-around being called in the cockpit: almost all aircrew in this state — 97 percent — continue to land. It can be argued, therefore, that the almost complete failure to call go-arounds as a preventive mitigation of the risk of continuing to fly approaches that are unstable constitutes the number one cause of runway excursions, and therefore of approach and landing accidents. If our go-around policies were effective even 50 percent of the time, the industry accident rate would be reduced 10 to 18 percent. There is no other single decision, or procedure, beyond calling the go-around according to SOPs that could have as significant an effect in reducing our accident rate. Why, then, is compliance so poor?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The Foundation in 2011 initiated a Go-around Decision Making and Execution Project designed to mitigate runway excursions caused by unstable approaches by achieving a high level of pilot compliance with go-around policies. This project expects enhanced compliance to result from answering the research question, "Why are go-around decisions, that should be made according to policy, actually not being made during so many unstable approaches?" and then making recommendations based on the findings. The project, which is ongoing, also will examine the psychosocial contributions behind flight operations management's role in the phenomenon, as well as the risks associated with flying the go-around maneuver itself.

In a series of articles to be published in *AeroSafety World* over the course of this year, we will describe the latest results of the project's work, which to date includes a worldwide pilot survey conducted on behalf of the Foundation by The Presage Group. The survey is designed to understand the psychology of decisions to go around rather than to continue to fly unstable approaches.

This first article describes a novel strategy for understanding this psychology, which we call the Dynamic Situational Awareness Model (DSAM), that we successfully have applied in several other operational contexts to help mitigate risk and increase compliance. The remaining articles will include the results of two experiments conducted within the pilot survey in which we assessed factors leading up to a decision. The experiments attempted to answer such questions as: "Are go-arounds associated more with some kinds of instabilities than with others?"; "What sorts of pilot characteristics, if any, are associated with go-around decision making?"; "What information did pilots solicit to assess risk prior to making their decisions?"; "What is the implicit incentive structure for flying go-arounds versus continuing the unstable approach that pilots perceive in their organization's culture?"; "What is the nature of the crew interactions that support compliance with go-around policies?"; "In hindsight, to what factors do pilots attribute their decisions to go around or continue with an unstable approach, and do these reflect all the experiences that were actually inputs to their decisions?"; "What are the true key drivers of their risk assessments and decisions?"; "Do pilots experience any post-decisional regret for non-compliance with go-around decision making protocols?"; "Do pilots accept the basic definitions set by their organizations for what defines an unstable condition, as well as the standard operating procedures (SOPs) their organizations have set out to handle them?"; and "Apart from their company's definitions, beyond what thresholds of instability on key flight parameters do pilots personally define themselves to be in an unstable state that warrants a go-around decision?"

By understanding more completely the answers to these questions, our goal is to bring new thinking to bear on the topic of non-compliance with unstable approach SOPs, and to offer ideas about how to mitigate these risks based on a better alignment of pilot psychology with company policy.

Dynamic Situational Awareness Model

Why is an investigation into situational awareness a valuable method for understanding a pilot's decision making? Well, put very simply, prior to the pilots' ability to accurately assess the operational landscape for potential threats and risks to aircraft stability, which would then shape their decision making around compliance, they must first and foremost be *fully aware* of the objective world around them.

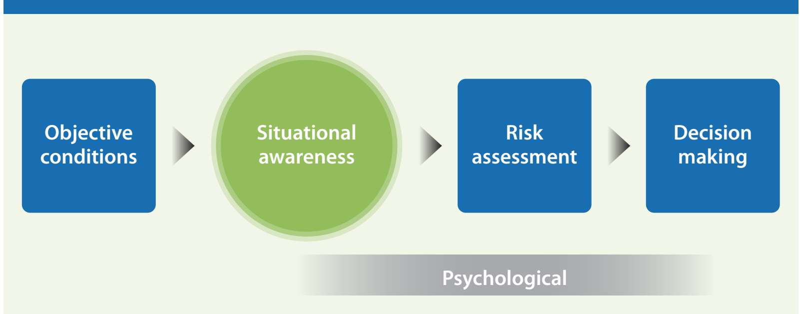
In other words, the pilots' very first psychological or cognitive act is being aware of their environment, in all of its facets, and it is this awareness that shapes and molds subsequent perceptions of operational risks and threats, and of the manageability of those risks and threats. These perceptions and judgments in turn inform decision making around risk appetite and compliance. From a psychological research point of view, it makes sense to test whether low situational awareness does in fact equate with poor risk assessments and increased rates of non-compliance during the unstable approach. In order to fully picture how DSAM is lived by pilots during an unstable approach, consider the following description.

Within the DSAM model, situational awareness comprises nine distinct but interconnected and seamless sub-aspects of awareness.

Imagine, a pilot-in-command and his/her crew are flying a routine approach when they experience a late-developing instability below stable approach height (SAH; as defined by their company). How might we describe the psychology of this situation up to and including the moment when this pilot decides to go around or not, and the experiences of both the pilot flying and other crewmembers as they handle this rapidly changing situation under time pressure and heavy workload?

In the cognitive realm, what thoughts, beliefs, expectations and information factor into their situational appraisal of the instabilities and their manageability? By what cognitive calculus do they assess risks of both choices, continuing to land or going around? What other pre-cognitive, intuitive, emotional and implicit knowledge comes into play? And how does their immediate cockpit environment — the social realm, including the important contributions of crewmembers, of communications styles and of interpersonal dynamics — influence their decisions?

How Situational Awareness Plays a Role in Decision Making



Source: The Presage Group

Figure 1

In Figure 1, we present the simplified sequence of events leading up to a decision between continuing an approach that is unstable in this scenario versus deciding to fly a go-around maneuver. Changing objective flight conditions and developing instabilities (step 1 in the sequence) must be noticed via the pilot's senses, registered and mentally processed in light of their always-developing expectations about their current situation.

Situational awareness of the environment, in all its facets and continuous state of flux (step 2), is the psychological prerequisite state for a pilot to judge risk at any moment (step 3), and then to make a subsequent decision to maintain compliance and safety in light of that judgment (step 4). This state of awareness must be continuously updated and refreshed based on a stream of sensory inputs and knowledge provided by the pilots' instruments, the kinesthetic and other senses, the crewmembers' inputs and so forth.

This study employed DSAM for measuring and interpreting the psychological and social factors that collectively make up situational awareness. Within this model, situational awareness comprises nine distinct but interconnected and seamless sub-aspects of awareness (Figure 2). Much of the following discussion will be framed around how each of these sub-aspects influences a pilot's risk assessment and decision-making processes, singly and in concert with one another, to remain compliant versus non-compliant in the face of aircraft instabilities while on approach.

In a typical response to the unstable approach event we have imagined, a typical *situational awareness profile* (SAP) emerges for the pilot flying the aircraft so as to maintain compliance with company SOPs. The "sequence" of processes might look something like the following. Imagine again our late-developing instability below SAH, and consider the pilots' phenomenological experiences of it, as it is *lived*, through its description as an SAP. *(Note: While we have serialized the subsequent description in steps to easily explain the various DSAM awareness concepts, these awarenesses actually exist in a mutually interdependent whole of causation, with rapid feedback loops and interactions. Changes to one type of awareness quickly influence the others in a psychological process called "spreading activation.")*

Example of a Go-Around Experience

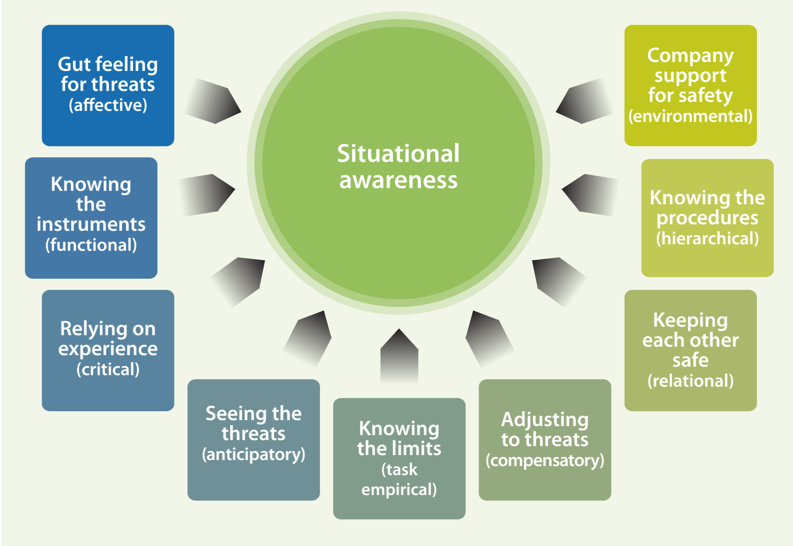
1. At a point immediately above SAH, the pilot's "gut," or what we refer to as *affective awareness*, subtly signals him or her to confirm that the aircraft's flight characteristics and profile are normal. In a near-instantaneous and seamless fashion, this might be followed by …

2. A visual check, or what we refer to as a check to provide *functional awareness*, which would be made where the pilot's expert knowledge and ability to understand the instruments plays a key role in confirming whether the cue from their gut was, in fact, correct. Simultaneously, there is …

3. An immediate and confirmatory statement from the pilot's network of past experiences, or *critical awareness*, occurs, in which professional experience confirms the presence of a "normal" flight profile. Seconds later, however, imagine that in continuing its descent below SAH, the aircraft encounters significant turbulence with headwinds shifting to tailwinds and downdrafts altering V_{REF} (reference landing speed) by +21 kt, accompanied by a vertical descent now greater than 1,100 fpm. Instantly, …

4. The pilot's *anticipatory awareness*, the ability to see these threats, registers in harmony with the reactivated gut, expert instrument knowledge and experience — all awarenesses that are now signaling a non-normal event — and there arises an immediate need for a signal from …

Breaking Down Situational Awareness



Source: The Presage Group

Figure 2

5. *Task-empirical awareness*, the pilot's expert knowledge of the safe operational envelope limits of the aircraft. Imagine further that this expert knowledge confirms that although the aircraft is now unstable, it still remains within the safe operational envelope. However, before concluding that parameters are now safe or unsafe, manageable or unmanageable, this developing event requires immediate input from another awareness competency …

6. *Compensatory awareness*, or the ability to understand how to compensate correctly for non-normal events, occurs by referencing through *functional awareness* whether the aircraft and the instruments will direct the flight state back to a normal condition if acted upon. Whether

the answer, not yet fully formed but informed by critical awareness, is likely to be "yes," "no" or uncertain, imagine that the pilot is also simultaneously receiving …

7. Through *relational awareness* — the pilots' knowledge of how they use their relationships to protect safety — input from a crewmember that re-enlivens a memory trace of a prior verbal signal, based on a conversation and agreement earlier in the approach initiated by the pilot monitoring, that a go-around might be necessary should the aircraft become unstable at or below SAH, which …

8. Informs and motivates the pilot to engage *hierarchical awareness*, or the individual's expert knowledge of operational procedures under specific operational conditions, so as to confirm their ability to safely fly a go-around if necessary. Finally, with the pilot-in-command and other crew rapidly coming to a common assessment of, and agreement about, the risks inherent in continuing with the unstable situation that faces them, in comparison with the inherent risks of any go-around maneuver, and

9. Confident that their company would support a decision to initiate a go-around, and in an expression of their *environmental awareness* concerning the wider organizational reward structures surrounding support for safety, the pilot flying puts all of these elements of awareness together to judge that the risks confronting the flight crew are not fully manageable, and so decides to call for a go-around.

Again, this description is not in any way intended to be prescriptive, that is, to suggest the way the dynamic situational awareness processes should work in this situation (i.e., the sequence or interactions among the awareness types). But it does illustrate that each of these awareness competencies needs to be used repeatedly and quickly to keep the entire spectrum of potential threats in the situation and their possible causes and resolutions alive in awareness at all times, and that there is a natural system of mutual causation among them that also must be sustained to maximize safe decision making.

Table 1 summarizes the complete system of nine DSAM concepts (called Construct 1 to Construct 9). The table shows a working name for each concept, its scientific name within our system and a brief definition.

What's Ahead?

So far, we have summarized the problem and described the psychological theory behind our experimental survey framework. Robust experimental survey work, which we will describe in the next articles in this series, provides valid data and meaningful insight and understanding into this critical issue for flight safety, and from which we can begin to define necessary corrective actions.

We will describe the results from more than 2,300 pilots asked to recall in detail the *last instance* in which they experienced an unstable approach.

In these articles, we will describe the results from analyzing data from more than 2,300 pilots asked to recall in detail the *last instance* in which they experienced an unstable approach that either led to a go-around decision or a decision to continue in the unstable state and land. In addition to reporting about various aspects of the DSAM model that differ between pilots going around and those continuing the unstable approach, we will also describe the kinds of objective flight conditions and pilot characteristics that are associated with these decisions, post-event perceptions pilots had about the causes of their decisions and hindsight judgments they made about the wisdom of their choices.

We will also describe the results of a second experiment conducted using the same survey, which was designed to investigate the personally held thresholds for instability that pilots believed would necessitate a go-around

Constructs in the Dynamic Situational Awareness Model

DSAM Construct Name	Description
"Gut feeling for threats" Affective awareness (C1)	Pilot's gut feelings for threats; seat of the pants experience, which is characterized by an emotional, sensory experience that triggers further cognitive analysis.
"Knowing the instruments and equipment" Functional awareness (C2)	Pilot's expert knowledge of knowing how to read and translate what his/her instruments are telling him/her.
"Relying on experience" Critical awareness (C3)	Pilot's ability to draw from his/her personal and professional experience bank as a means to assess here-and-now events as "normal" or "abnormal."
"Seeing the threats" Anticipatory awareness (C4)	Pilot's ability to see and/or monitor real and potential threats as they move and change over time and through space.
"Knowing the limits" Task-empirical awareness (C5)	Pilot's expert knowledge of the safe operational envelope of his/her equipment.
"Adjusting to threats" Compensatory awareness (C6)	Pilot's ability to know how and when to compensate or adjust correctly for present and anticipated future operational conditions to ensure safe SOP-compliant operations.
"Keeping each other safe" Relational awareness (C7)	Pilot's ability to accurately assess and engage crewmember relationships in a manner that protects safety and compliance.
"Knowing the procedures" Hierarchical awareness (C8)	Pilot's expert and comprehensive knowledge of operational procedures, their order and correct sequencing.
"Company support for safety" Environmental awareness (C9)	Pilot's experience of how his/her company supports and encourages safety and how this in turn shapes his/her commitment to safe and compliant behavior.

DSAM = Dynamic Situational Awareness Model; SOP = standard operating procedure

Note: The informal construct names in quotes appear above the corresponding standardized terms from the Presage researchers' glossary.

Source: The Presage Group

Table 1

call, considering deviations in several flight parameters. Later articles will report on other aspects of the FSF project, including the results of the management survey on this topic conducted in parallel with the pilot survey, and a study of the risks inherent in the go-around itself.

Along the way, we will offer high-level observations and recommendations about the kinds of systemic mitigations that might be implemented to combat the various causes of pilot decisions not to go around while flying unstable approaches.

The Presage Group specializes in real-time predictive analytics with corrective actions to eliminate the behavioral threats of employees in aviation and other industries. Further details of the methodology of their survey, experiments and results are described at <www.presagegroup.com>.

Notes

1. Flight Safety Foundation. "Reducing the Risk of Runway Excursions." Runway Safety Initiative, May 2009. <flightsafety.org/files/RERR/fsf-runway-excursions-report.pdf>

2. Burin, James M. "Year in Review." In *Proceedings of the Flight Safety Foundation International Air Safety Seminar*. November 2011.

Unintended

'Abrupt and unusual' control movements led to the fatal crash of an EC135, the NTSB says.

BY LINDA WERFELMAN

Abrupt control movements — which "highly likely" resulted when a 5-year-old girl moved from her father's lap and inadvertently stepped on the collective — were the probable cause of the Feb. 14, 2010, fatal crash of a Eurocopter EC135 in Cave Creek, Arizona, U.S., the U.S. National Transportation Safety Board (NTSB) says.

The NTSB cited as a contributing factor the "absence of proper cockpit discipline from the pilot."

The pilot and all four passengers were killed in the crash, which occurred in visual meteorological conditions around 1505 local time during a planned flight from Whispering Pines Ranch near Parks, Arizona, to Scottsdale Airport, about 150 mi (241 km) to the south.

© Jason R. Fortenbacher/Fight to Fly Photography

In the final accident report approved in November 2012, the NTSB said its investigation revealed that a rotor blade had struck the left horizontal endplate and the tail rotor drive shaft, resulting in the loss of control that preceded the crash.

"The only way that this condition could have occurred was as a result of a sudden lowering of the collective to near the lower stop, followed by a simultaneous reaction of nearly full-up collective and near full-aft cyclic control inputs," the report said. "A helicopter pilot would not intentionally make such control movements."

The report quoted the ranch foreman as telling NTSB investigators that, on the day of the accident, the pilot loaded the helicopter and conducted the preflight inspection before climbing into the right front cockpit seat and starting the engines. Two adult passengers and two dogs were boarded before the foreman observed the owner and his daughter, whose weight was estimated at 42 lb (19 kg), board through the left forward cockpit door.

The owner and his daughter both sat in the left front cockpit seat, "with the small girl positioned on her father's lap," the report said. "When asked how frequently the child occupied the left front cockpit seat with her father, the ranch foreman replied 'occasionally.' The foreman stated that he could not tell if either the helicopter owner or the child were secured and restrained in the helicopter. The foreman revealed that on previous flights, the helicopter owner had strapped his daughter in on top of him."

Witnesses near the crash site, about 14 nm (26 km) north of Scottsdale Airport, said they heard popping or banging sounds before the helicopter descended and crashed into the ground. Some said they saw parts of the helicopter separate in the final seconds of flight, before it "circled and dove to the ground," the report said. The helicopter struck the ground in a river wash area and was consumed by fire.

The helicopter crashed near a river wash on a gravel access road about 14 nm (26 km) north of Scottsdale Airport.

U.S. National Transportation Safety Board

11,000 Flight Hours

The 63-year-old helicopter pilot had about 11,000 flight hours, including 824 hours in the EC135 T1 and 13 hours in the 90 days before the accident, according to flight operations personnel at Services Group of America (SGA), which owned the helicopter. He also had a second-class medical certificate. Investigators did not obtain the pilot's logbook and found no record of military flight time, but SGA personnel said the pilot had flown U.S. Army helicopters during the Vietnam War.

His initial training in the EC135 T1 was completed in 2002, with recurrent ground and flight training in 2003, 2004, 2006 and 2008. All training records indicated that the pilot had performed satisfactorily and noted no deficiencies.

The owner of SGA was 64 and held a private pilot certificate for single-engine airplanes, issued in 1967. A review of FAA records revealed no indication that he held a medical certificate and little other information about his aviation background.

The owner did not have a helicopter rating, but in post-accident comments to accident investigators, the SGA chief pilot said that the owner "liked to fly" and that it was common for him to take the controls. The report said that investigators could not determine which man was flying at the time of the accident.

The report said that two American Eurocopter instructor pilots told accident investigators that, during training sessions, the accident pilot spoke of the pressure he felt in his job.

One instructor said the accident pilot "displayed an abnormally high degree of perceived pressure to accomplish flights from the owner of the helicopter" and was "visibly shaken when discussing the amount of pressure he received."

The instructor said that, during initial transition ground school training in 2002, the accident pilot had told him "that it would not be uncommon to fly the helicopter's owner from Seattle to his home of Vashon Island when the weather conditions at night were so poor that they would follow the ferryboat lights to navigate across the bay under foggy conditions."

The other instructor said that, during a 2008 training session, the accident pilot had commented "about the owner dominating the cockpit duties prior to a flight.

"I emphasized the importance of following the checklist and always performing the hydraulic check. He commented that when the owner flies, he gets in the cockpit and 'flips switches and goes.' I felt [the accident pilot] was intimidated by the owner and would not insist proper aircraft procedures be followed."

In information submitted by SGA for the accident investigation, the company's chief pilot questioned the instructors' accounts. He wrote that he considered the accident pilot as "not a pilot who would be intimidated" and "a conscientious and professional pilot, in every sense of the word."

Noting that the instructors had "inferred that [the accident pilot] feared for his job if he did not perform his trips regardless of risk," the chief pilot said, "After 24 years of service with Services Group of America, there could be nothing further from the truth. I do not believe that an individual could stay at any company that long if they felt such pressure from their employer." The accident pilot had left SGA in the late 1990s but returned three years later and remained with the company until his death, the chief pilot said.

Eurocopter EC135 T1

The EC135 is a twin-turbine light helicopter first flown in 1988 with two Allison 250-C20R engines.

The T1, first delivered to a U.S. customer in 1996, is the Turbomeca engine version. The accident helicopter was equipped with two TM USA Arrius 2B1 turboshaft engines.

The helicopter can be equipped to seat up to eight people. It has a maximum normal takeoff weight of 5,997 lb (2,720 kg), maximum cruising speed at sea level of 139 kt and a maximum range at sea level with standard fuel of 402 nm (745 km).

Source: *Jane's All the World's Aircraft*, U.S. National Transportation Safety Board Accident Report No. WPR10FA133

Three Incidents

The accident helicopter was manufactured in 1999, was purchased by SGA from its original owner in 2002 and had accumulated 1,116 operating hours. It had been maintained in accordance with the manufacturer's recommendations, and its most recent annual inspection had been conducted Oct. 30, 2009.

The helicopter had two Turbomeca USA Arrius 2B1 turboshaft engines. At the time of the October 2009 inspection, the left engine had recorded 1,103 hours total time since new, and the right engine, 227 hours.

The helicopter had been involved in three incidents before the crash, the report said.

In the first incident, in May 2003, the helicopter's owner was at the controls when the left seat — reportedly "not in the proper detent position" — slid aft, the report said.

"The helicopter dropped about 50 ft but was recovered by a quick collective input," the report said. "In an incident report submitted by American Eurocopter, it was reported that a loud bang was heard, followed by the touchdown of the helicopter."

The impact damaged the horizontal stabilizer, and pieces of the engine were found on the ground. The helicopter was repaired and returned to service in August 2003.

The second incident, with the accident pilot flying, involved a January 2004 hard landing at a grassy heliport on Vashon Island, Washington, U.S. After repairs, the helicopter was returned to service in April 2004.

In September 2007, an engine chip light illumination occurred, followed by a yaw, an engine shutdown and a single-engine landing; the engine was replaced in January 2008.

In addition, one of the helicopter's main rotor blades was removed in November 2009 because maintenance personnel could not balance it correctly, and a temporary replacement blade was installed. The replacement was still in place when the accident occurred.

In most helicopters, including EC135s, the collective pitch control lever is on the left side of the pilot's seat.

U.S. National Transportation Safety Board

Clear Skies

Visual meteorological conditions prevailed at the time of the accident, with clear skies, 10 mi (16 km) visibility and no wind.

Air traffic control facilities had no contact with the pilot on the day of the accident. Radar showed the helicopter flying south toward Scottsdale from Whispering Pines Ranch; the last radar return was recorded at 1503:37, about two minutes before impact. An NTSB radar study said the helicopter's last known position was about 14 nm (26 km) north of Scottsdale Airport, above the accident site at 3,700 ft above mean sea level.

The NTSB investigation found that a single impact of one of the main rotor blades had damaged the tail rotor drive shaft.

"No pre-impact failures or material anomalies were found in the wreckage and component examinations that could explain the divergence of the … blade from the plane of main rotor rotation," the report said.

The most likely explanation, the report added, was that "all of the main rotor blades were following a path that would have intersected the tail rotor drive shaft as a result of an abrupt and unusual control input."

The report said investigators had conducted a biomechanical study that showed that "it was feasible that the child passenger … could fully depress the left-side collective control by stepping on it with her left foot" to stand up from her place in her father's lap.

"It is highly likely that the child inadvertently stepped on the collective with her left foot and displaced it to the full down position," the report said. "This condition would have then resulted in either the pilot or the helicopter owner raising the collective, followed by a full-aft input pull of the cyclic control and the subsequent main rotor departing the normal plane of rotation and striking the left endplate and the aft end of the tail rotor drive shaft."

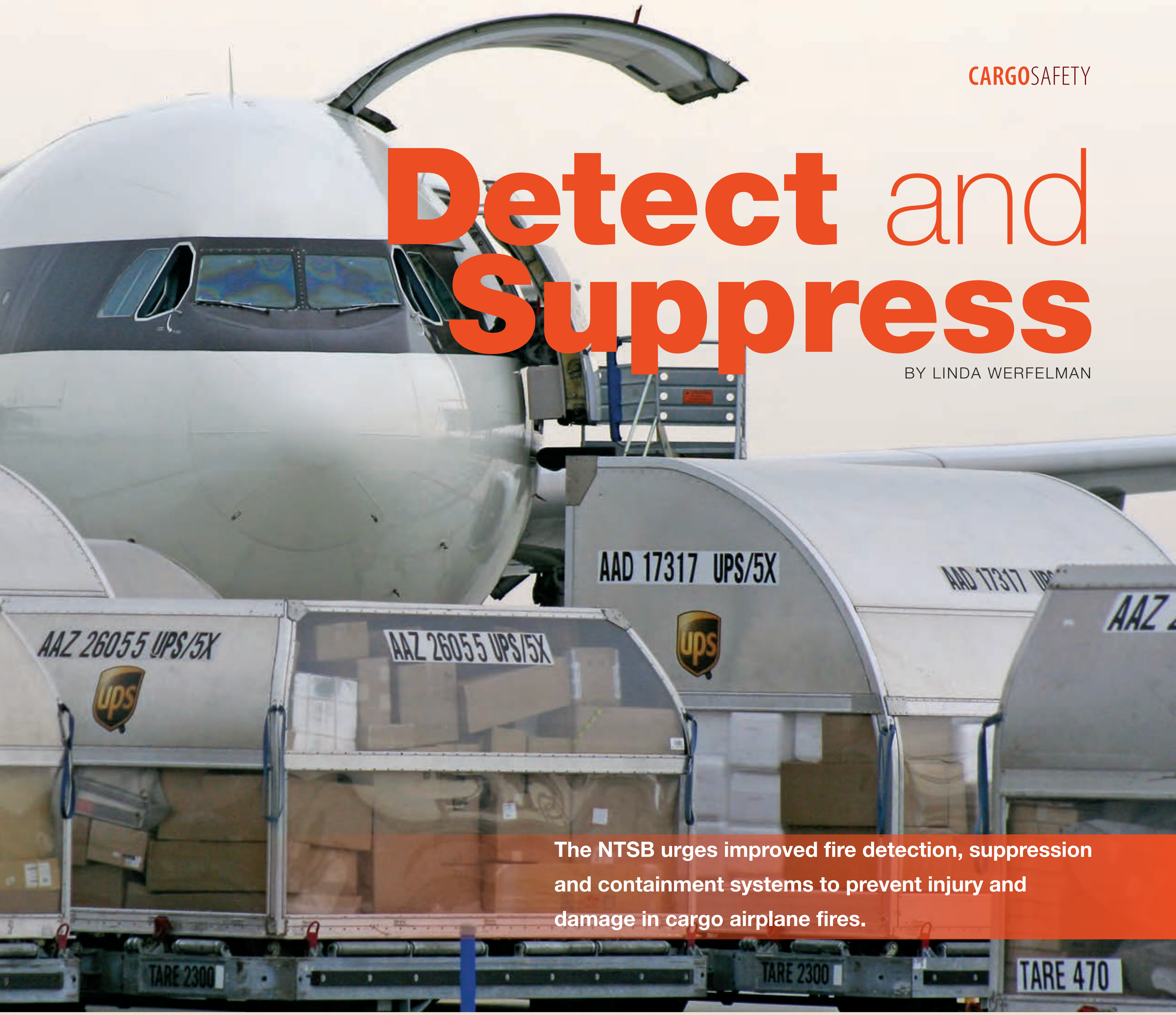
This article is based on NTSB accident report no. WPR10FA133 and accompanying docket information.

Note

1. The collective pitch control is the part of a helicopter's flight control system that simultaneously changes the pitch angle of all main rotor blades. In the EC135, and in most other helicopters, the collective is on the left side of each pilot's seat. The cyclic, located in the EC135 between the pilot's legs at the center of each pilot's seat, changes the pitch of the rotor blades one at a time, as each blade rotates past the same point in the rotor disk.

Detect and Suppress

BY LINDA WERFELMAN



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The NTSB urges improved fire detection, suppression and containment systems to prevent injury and damage in cargo airplane fires.

Existing fire-protection regulations for cargo airplanes are inadequate, and action is needed to improve the detection and suppression of blazes in cargo containers, the U.S. National Transportation Safety Board (NTSB) says.

The agency cited information gathered in its recent cargo container fire study and the investigations of three in-flight cargo airplane fires — a February 2006 fire on a United Parcel Service (UPS) McDonnell Douglas DC-8-71F; the fatal September 2010 crash of a UPS Boeing 747-400F; and the fatal July 2011 crash of an Asiana Cargo 747-400F (“In-Flight Fires,” p. 35) — in issuing three safety recommendations in late November to the U.S. Federal Aviation Administration (FAA).

“These fires quickly grew out of control, leaving the crew with little time to get the aircraft on the ground,” NTSB Chairman Deborah A.P. Hersman said. “Detection, suppression and containment systems can give crews more time and more options. The current approach is not safe enough.”

The NTSB’s recommendations call on the FAA to:

“Develop fire detection system performance requirements for the early detection of fires originating within cargo containers and pallets and, once developed, implement the new requirements;

"Ensure that cargo container construction materials meet the same flammability requirements as all other cargo compartment materials in accordance with [U.S. Federal Aviation Regulations (FARs) Part 25.855]; and,

"Require the installation and use of active fire suppression systems in all aircraft cargo compartments or containers, or both, such that fires are not allowed to develop."

Cargo aircraft currently are subject to the same FAA fire-protection regulations that govern all transport category aircraft, the NTSB said.

"Although these regulations limit the flammability of construction materials used in cargo compartments and also specify minimum fire resistance requirements for cargo compartment liners, there is limited regulation concerning fire protection associated with cargo containers," the NTSB said.

For example, the agency noted that materials selected for the construction of cargo containers undergo a horizontal Bunsen burner test, "which does not prevent the use of highly combustible materials."

Smoke billows from an aluminum and polycarbonate cargo container during flammability tests.

U.S. National Transportation Safety Board

In addition, "the effect of the use of containers and pallets to contain cargo is not factored into the current overall fire protection strategy or certification process," the NTSB said, noting that the certification process is conducted using empty cargo compartments.

In a letter to then-Acting FAA Administrator Michael Huerta that accompanied the safety recommendations, the NTSB discussed the findings of accident investigations and a series of tests conducted in August 2011 to develop a better understanding of cargo container fires and the most appropriate prevention strategies.[1]

The tests — designed in part to examine the burning characteristics of cargo container fires — prompted researchers to conclude that "container design has a significant effect on the time it takes for an internal fire to become detectable to a smoke detector outside the container" and that "container construction materials have a significant effect on the total fire load[2] and energy release rate of a cargo fire," the NTSB said.

In the two accidents in 2010 and 2011, investigators found "a relatively short interval between the time a fire warning indication was delivered to the flight crew and the onset of flight control and aircraft system failures," the NTSB said. In the fatal UPS crash, about 2 minutes 30 seconds elapsed between the first fire warning and the loss of some aircraft systems; timing information has not been released in the ongoing Asiana investigation, the NTSB said.

The NTSB's report on the 2011 tests, published in a report in March 2012, concluded that "the time it takes for a fire detection system to detect a fire originating within a cargo container may easily exceed the one-minute time frame specified in … Part 25.858(a)" and that "the growth rate of container fires after they become detectable by the aircraft's smoke detection system can be extremely fast, precluding any mitigating action and resulting in an overwhelming fire."

In tests of cargo containers, the NTSB found that the time between fire initiation and fire detection ranged from 2 minutes 30 seconds to 18 minutes 30 seconds — longer than the one-minute detection time currently required.

"The fires grew very large, capable of causing significant damage to an aircraft, shortly after becoming a detectable fire," the report said. "The NTSB is concerned that, when fires inside containers become detectable to the aircraft's smoke-detection system, there is little time until the fires reach levels that can compromise the integrity of the cargo compartment and then threaten the structure and systems of the aircraft. …

"If the fire were to be detected while generating smoke inside the container, valuable time would be gained for alerting flight crews and mitigating the effects of the fire."

Because existing regulations dealing with flammability limits are "very limited" for cargo container materials, those materials can significantly increase the fire load within a cargo compartment, the NTSB said.

For example, the agency cited collapsible containers made from corrugated polypropylene as "significant contributors" to fire intensity.

Fire Suppression

Most current practices base fire suppression in main deck cargo compartments on passive suppression systems, such as the use of fire-resistant materials and oxygen deprivation. Because the compartments are so large, however, fires can become very large before oxygen deprivation slows their growth, the NTSB said.

In the 2006 UPS blaze, the agency said, "the aircraft did not achieve depressurization [which aids in suppressing flames] until after system failures and flight control issues began to occur."

Tests by FAA researchers have found that, although depressurization contributes to fire suppression, when an aircraft descends to a more oxygen-rich environment, the fire again begins to grow.

"Hence, experience from the UPS [Dubai] accident, as well as FAA experiments, suggest that passive fire suppression in large cargo compartments due to oxygen deprivation may not be effective," the NTSB said.

In-Flight Fires

Three in-flight cargo airplane fires were cited by the U.S. National Transportation Safety Board (NTSB) in its recommendations for improved fire safety.

The first was a Feb. 7, 2006, fire in a United Parcel Service (UPS) McDonnell Douglas DC-8-71F, which landed at Philadelphia International Airport after the crew smelled smoke and then — 20 minutes later — the "CARGO SMOKE" light illuminated (*ASW*, 4/08, p. 28).

All three crewmembers were treated for minor injuries from smoke inhalation, and the airplane was destroyed. The NTSB said the cargo fire began "from an unknown source," probably inside one of the DC-8's cargo containers; contributing factors were the "inadequate certification test requirements for smoke and fire detection systems and the lack of an on-board fire suppression system."[1]

Deborah Hersman, a member of the NTSB and now its chairman, said during the agency's public hearing on the accident that the flight was "seconds from disaster."

The second fire broke out on a UPS Boeing 747-400F that crashed Sept. 3, 2010, inside an army base near Dubai International Airport (DXB) in the United Arab Emirates. The two flight crewmembers were killed, and the airplane was destroyed.

An interim report by the UAE General Civil Aviation Authority (GCAA) said that a fire warning light illuminated about 22 minutes after takeoff from DXB while the airplane was in cruise at 32,000 ft. The crew declared an emergency, and the airplane crashed as they maneuvered to land at DBX. The investigation is continuing.[2]

The third fire occurred July 28, 2011, on an Asiana Cargo 747-400F, which crashed 70 nm (130 km) west of Jeju Island, Republic of Korea, as the flight crew attempted to divert to Jeju International Airport because of the fire. Both pilots were killed, and the airplane was destroyed. The investigation by the South Korean Aircraft and Railway Accident Investigation Board (ARAIB) is continuing.[3]

— LW

Notes

1. NTSB. Accident Report No. NTSB/AAR-07/07, "Inflight Cargo Fire; United Parcel Service Company Flight 1307; McDonnell Douglas DC-8-71F, N748UP; Philadelphia, Pennsylvania; February 7, 2006." Dec. 4, 2007.
2. GCAA. Accident Reference 13-2010, "Air Accident Investigation Interim Report: Boeing 747-44AF, N571UP; Dubai, United Arab Emirates; September 03, 2010."
3. ARAIB. ARAIB/AAR1105, "Aircraft Accident Investigation Interim Report: Crash Into the Sea After an In-Flight Fire; Asiana Airlines, B747-400F/HL7604; 130 Km West of Jeju International Airport; July 28, 2011."

The agency noted that, in 2007, as a result of its investigation of the 2006 fire, it had recommended that the FAA require fire-suppression systems for the cargo compartments of all FARs Part 121 cargo airplanes. The NTSB reported that the FAA's response had been that the cost of installing "compartment-flooding fire-suppression systems, as those used in Class C cargo compartments,[3] was not justified for the main deck cargo compartments of aircraft of any weight."

However, the NTSB said that the fires in 2010 and 2011 "continue to demonstrate the critical need to suppress cargo fires."

As an alternative to the compartment-flooding system evaluated by the FAA, the NTSB suggested alternatives, including the "aircraft-based system" used by FedEx and in-container suppression systems being developed by the industry.

'Multi-Layered Approach'

The NTSB's issuance of the safety recommendations coincided with an announcement by UPS that it had developed a "multi-layered approach consisting of matched solutions that include checklists, training and new technologies" to mitigate in-flight cargo fires.

Among those new technologies are fire-resistant fiber-reinforced plastic containers, experimental fire-suppression units that "smother a fire with potassium aerosol powder and can save 95 percent of packages in the container" and fire-containment covers for palletized cargo.

The approach was developed by a UPS/Independent Pilots Association task force that had identified as its first step "increasing the time a crew had to manage a smoke or fire event," said Capt. Bob Brown, a task force member.

The group's goal was to contain a fire inside a unit load device (ULD) for four hours. In a test in October, a ULD containing 215 packages, including "20 working laptops with batteries, 50 working cell phones with batteries and 300 bulk-shipped lithium ion batteries, was set on fire by six lithium ion batteries," Brown wrote in *Leading Edge*, the UPS flight operations and safety magazine.[4] "Although temperatures reached as high as 1,200 degrees [F (649 degrees C)], the fire was suppressed for four hours and 95 percent of the packages were undamaged. Even the laptops worked."

UPS said that it also is installing quick-donning integrated oxygen masks and smoke goggles in all aircraft, and the VisionSafe Corp. Emergency Vision Assurance System (EVAS), designed to displace smoke in a pilot's vision path to allow him or her to see basic flight instruments and the flight path, as well as emergency checklists and navigation charts.[5]

Automatic Suppression Systems

FedEx Express began installing on-board automatic fire-suppression systems in its aircraft in 2009, the same year it won the FSF-Honeywell Bendix Trophy for Aviation Safety for developing the devices (*ASW*, 11/09, p. 39).

The system incorporated infrared heat sensors, foaming-agent generators and an overhead cargo-container injector. If the sensors detect heat in a cargo container, the overhead fire-suppression equipment activates, piercing the container and injecting argon foam. At the same time, the crew is alerted.

Notes

1. NTSB. Materials Laboratory Study Report No. 12-019. March 21, 2012. In addition to addressing the burning characteristics of container fires, the study also examined the fire-load contribution of lithium and lithium-ion batteries. The NTSB noted that the involvement of these types of batteries "has come into question" in both the 2006 fire and the 2010 fire.
2. *Fire load* is defined by the NTSB as "the amount of combustible material that can become involved in a fire."
3. Class C cargo compartments have smoke or fire detector systems that provide warnings on the flight deck; built-in, pilot-controlled, fire-suppression systems; methods of excluding hazardous amounts of smoke from any occupied portions of the airplane; and methods of controlled compartment ventilation.
4. Brown, Bob. "UPS/IPA Safety Task Force Pioneers Advancements in Aviation Safety." *Leading Edge* (Fall 2012): 2.
5. VisionSafe Corp. *EVAS.* <visionsafecorporation.com/VisionSafe_Corporation/Product_Info.html>.

Sandy: A Different Type of Storm

BY ED BROTAK

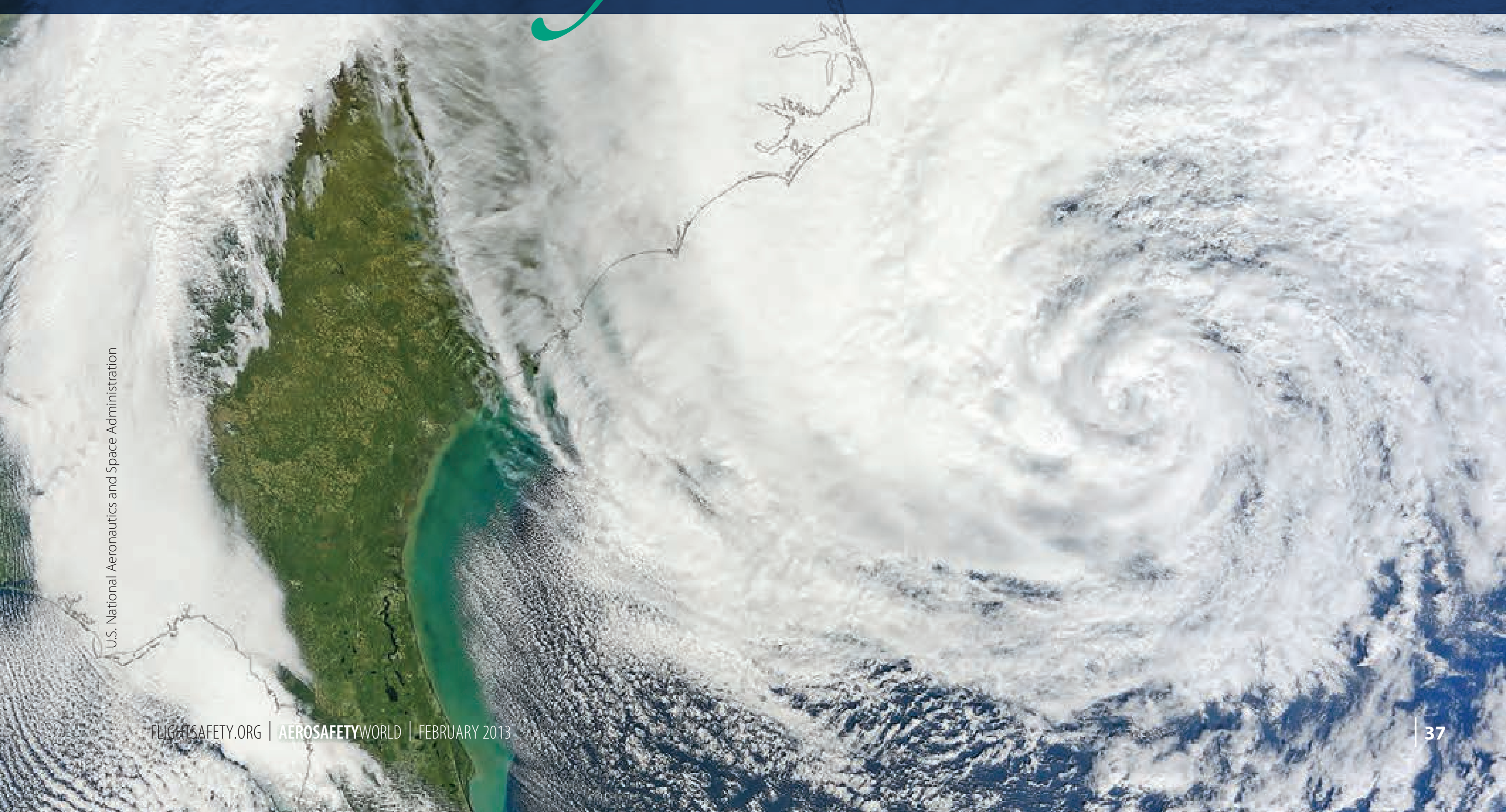
"Superstorm" Sandy will go down as one of the most destructive storms in the history of the United States. Total losses may exceed $50 billion, and estimated losses for the airline industry are near $500 million. More than 20,000 flights were canceled starting Sunday, Oct. 28, 2012, and continuing through Wednesday, Oct. 31.

Particularly hard hit was the New York City area. LaGuardia Airport, which is located on a waterfront, suffered significant damage, with the tarmac flooded, and did not reopen until Nov. 1. In anticipation of Sandy's strong winds, New York City's three major airports closed Sunday night. Weather conditions steadily deteriorated overnight. Winds were gusting over 40 kt by morning. In the evening, wind gusts near 70 kt were recorded, and at times, wind-driven rain severely lowered visibility.

The magnitude of the storm can be seen by looking at the peak wind gusts reported at various airports along the U.S. East Coast: Dulles International Airport outside Washington, 47 kt; Philadelphia International Airport, 59 kt; John F. Kennedy International Airport in New York, 69 kt; Boston Logan International Airport, 52 kt; Portland (Maine) International Jetport, 48 kt. All of these peak gusts occurred within several hours on the evening of Oct. 29.

Even after winds subsided on Tuesday, Oct. 30, and flying conditions improved, widespread power outages and a lack of surface transportation impeded airport operations. Structural damage to buildings and significant damage to aircraft on the ground were reported.

Throughout its duration, the storm was referred to as Sandy, the name given when it first reached tropical storm status on Oct. 23. As Sandy was ravaging New York and New Jersey on Oct. 29, meteorologists stopped calling it a hurricane, even though it maintained the same intensity. Technically, just as Sandy was coming ashore near Atlantic City, New Jersey, it became a midlatitude or extratropical cyclone, losing its tropical



U.S. National Aeronautics and Space Administration characteristics. The U.S. National Weather Service continued to use the name Sandy to avoid public confusion. The results — the wind, the rain and the massive storm surge — were the same, regardless of the nature of the storm.

So, why should we be concerned if a storm is tropical, extratropical or something in between? Consider these elements of Sandy: The storm was 1,000 mi (1,609 km) across, more than twice the size of the large and extremely destructive Hurricane Irene that affected this same region in August 2011. When Irene came up the East Coast, it weakened considerably over the cooler waters, typical of a true tropical system. Sandy did not weaken, even though it traversed the same waters nearly two months later in the year. In fact, it strengthened. The central pressure fell to 940 millibars (mb; 27.76 in Hg), 20 mb lower than the famed superstorm that moved up the East Coast in March 1993.

What are the differences between tropical cyclones such as hurricanes and extratropical cyclones, the typical winter storms?

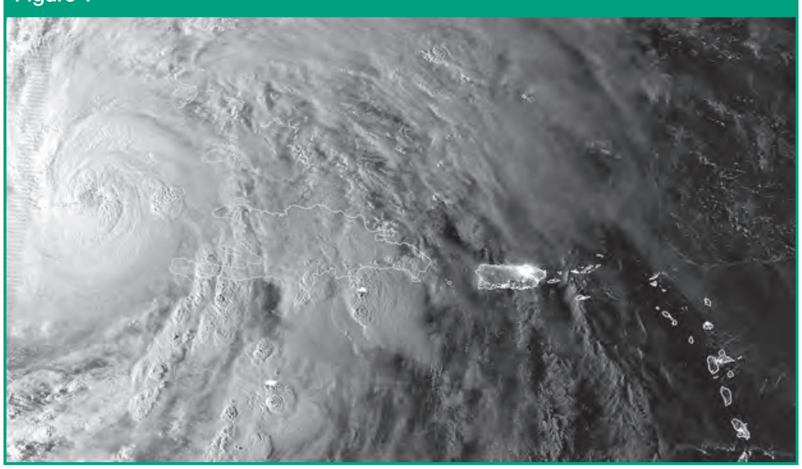
Tropical cyclones only develop over warm waters, usually in the lower latitudes. Extratropical cyclones can develop over land or water where the air is colder and have even occurred in Arctic regions. Extratropical cyclones require a temperature contrast to develop. They usually form along fronts that separate warm and cold air masses. Tropical cyclones develop within a single warm, humid air mass with no fronts involved. Tropical cyclones get their energy from the warm ocean water. Evaporation puts vast amounts of water vapor in the air. When the air is lifted in the storm's circulation, the water vapor condenses in the towering cumulonimbus clouds, releasing latent heat that drives the storm. Extratropical cyclones derive their energy from the temperature contrast between warm and cold air masses. Energy is released as the warm air is lifted over the cold.

An earlier article (*ASW*, 2/12, p. 48) described how a surface low pressure area is produced. Air is removed from above in the process called divergence. Air is lifted by the low pressure and then spreads over a larger area above the surface low. This removal of air lowers the surface pressure. For extratropical cyclones, the divergence aloft is produced on the east side of a pre-existent upper-level trough of low pressure. When this upper trough moves over a surface front, cyclogenesis — the process by which the low pressure area develops — occurs. For tropical cyclones, there are no pre-existent upper features. However, over time, the towering cumulonimbus clouds release enough heat aloft to develop a high pressure area over the low-level cyclone. This self-developed high, miles above the surface, provides the divergence aloft needed to maintain the surface storm.

It is not unusual for tropical cyclones to become extratropical. If the tropical system moves into higher latitudes, especially in the late fall, it can merge with a midlatitude frontal system and its attendant upper trough. Some of these converted storms can be very strong. The "textbook case" was Hurricane Hazel, which moved up the East Coast in 1954. Hazel came ashore along the extreme southern coast of North Carolina on Oct. 15. It was a powerful Category 4 (*ASW*, 7/12, p. 29) hurricane with maximum sustained winds of 110 kt and a minimum central pressure of 937 mb (27.67 in Hg). It almost immediately joined a strong cold front and began to accelerate to the north. Cold air poured into the system from the west, quickly transitioning the storm into an extratropical system. Unfortunately, weakening was limited, and by the next day, it passed Washington with a central

The storm was 1,000 mi (1,609 km) across, more than twice the size of the large and extremely destructive Hurricane Irene that affected this same region in August 2011.

Figure 1



U.S. National Aeronautics and Space Administration pressure of 970 mb (28.64 in Hg) and the transformed Hazel produced a gust at Washington National Airport (now Ronald Reagan Washington National Airport) of 98 mph, a record that still stands. Hazel continued hundreds of miles northward into Canada, still producing hurricane force winds, although its track was well inland.

Sandy made the transition to fully extratropical, probably a few hours before landfall on Oct. 29. Of more interest was what was happening with Sandy in the days prior to this. Sandy started as a pure tropical system. It formed in the Caribbean Sea on Oct. 22. Three days later, as it was coming ashore on the south coast of Cuba, Sandy was at its maximum strength as a purely tropical system — a strong Category 2 hurricane with maximum sustained winds of 100 kt and a central pressure of 954 mb (28.17 in Hg; Figure 1, p. 38). Tropical storm or gale force winds (34 kt or greater) spanned a diameter of 200 mi (322 km). By the next day, a weakened Sandy continued to move northward toward the Bahamas. The central pressure had risen to 969 mb (28.61 in Hg), and maximum winds were barely hurricane force (64 kt), but the storm had doubled in size with gale force winds covering 400 mi (644 km). And by late in the day on Oct. 26, Sandy no longer looked like a true tropical system on satellite imagery. It was still warm core with convection near the center, but it now had a long frontal-looking cloud band associated with it. Forecasters at the National Hurricane Center said in their technical discussion that they were dealing with a "hybrid cyclone," part tropical system, part extratropical system.

Meteorologists have known about hybrid storms for years. They have even classified one type of hybrid storm, the subtropical cyclone. These low pressure areas develop only over ocean areas and have characteristics of both extratropical and tropical cyclones. Most subtropical cyclones develop from midlatitude, deep upper-level troughs or closed lows. They actually develop downward and eventually produce a surface low. The cloud pattern resembles a comma, very noticeable on satellite imagery. The strongest winds, which can exceed hurricane force, are found well away from the center of the storm, unlike tropical systems. If this system sits over warm water, convection may develop near the center. The storm can become warm-core and tropical in

Figure 2

Figure 3

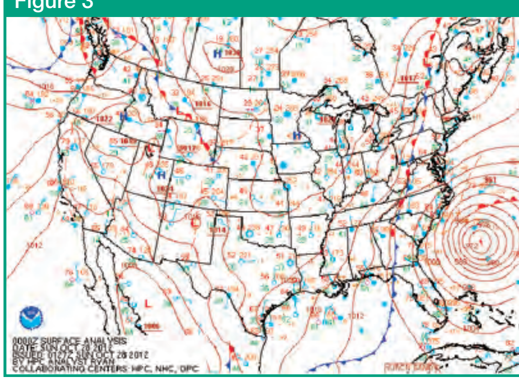
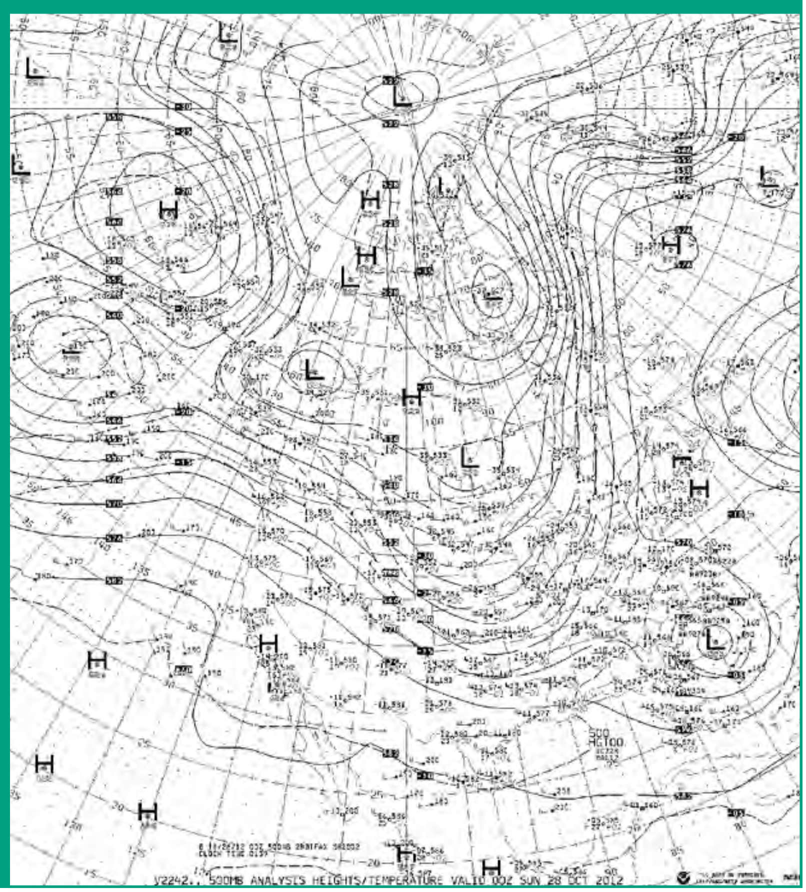


Figure 4



Images: U.S. National Oceanic and Atmospheric Administration nature. The convection and warm core are often confined to a small central region, surrounded by the extratropical part of the storm. So you can have a tropical cyclone embedded within a larger subtropical or even extratropical system. Subtropical cyclones are not limited to the Atlantic. The "Kona storms" that sometimes affect the Hawaiian Islands in winter are subtropical. Other subtropical cyclones have occurred in the Mediterranean Sea and the Indian Ocean.

Prior to Sandy, probably the most famous of the hybrids was the so-called Perfect Storm of 1991. Developing in the North Atlantic, south of Nova Scotia, Canada, in late October, this cyclone had peak sustained winds of 65 kt and a minimum central pressure of 972 mb (28.70 in Hg). Although it never came ashore, severe beach erosion occurred from the Canadian Maritimes to North Carolina. A buoy in the open ocean measured a wave height of 100 ft. At one point, convection developed near the storm center, and the inner core took on the structure of a tropical cyclone.

Sandy began to resemble a subtropical cyclone (Figure 2, p. 39), but Sandy was a tropical system that was acquiring extratropical characteristics, not vice versa. It featured a warm, tropical core embedded within a much larger non-tropical cyclone. It had two wind maxima, one near the center and one over 100 mi (161 km) north of the center. The surface map for 0000 coordinated universal time (UTC) on Oct. 28, 2012 (Figure 3, p. 39) shows Sandy off the Southeast coast. The front it will eventually merge with is to the west. The 500 mb (~18,500 ft, 5,500 m) chart for the same time (Figure 4, p. 39) depicts Hurricane Sandy as a warm core low off the Southeast coast. A powerful trough (cold core) is located in the middle of the United States. Not only is the trough steering Sandy to the north, but the divergence on the trough's eastern side is causing the pressure to fall in the storm, 10 mb in one day. Cooler water and increased wind shear should have weakened the storm. Sandy's peak winds remained the nearly the same, but the storm continued to grow in size.

Sandy moved parallel to the coastline on Oct. 28, while its central pressure continued to fall and the storm grew. The 1200 UTC Oct. 29 surface chart (Figure 5) shows Sandy well off the Virginia coast. The 500 mb chart for the same time (Figure 6) shows a large upper-level high over the Canadian Maritimes, blocking Sandy's northward march. At the same time, a closed, cold core low has formed over North Carolina. Sandy is being

Figure 5

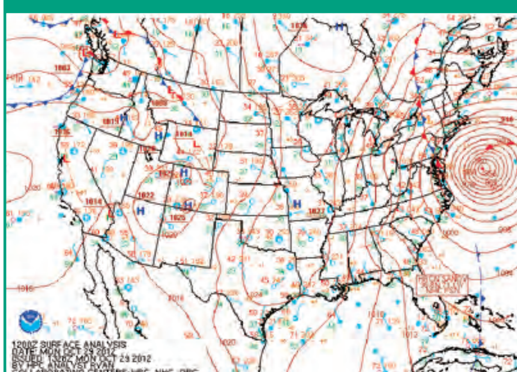
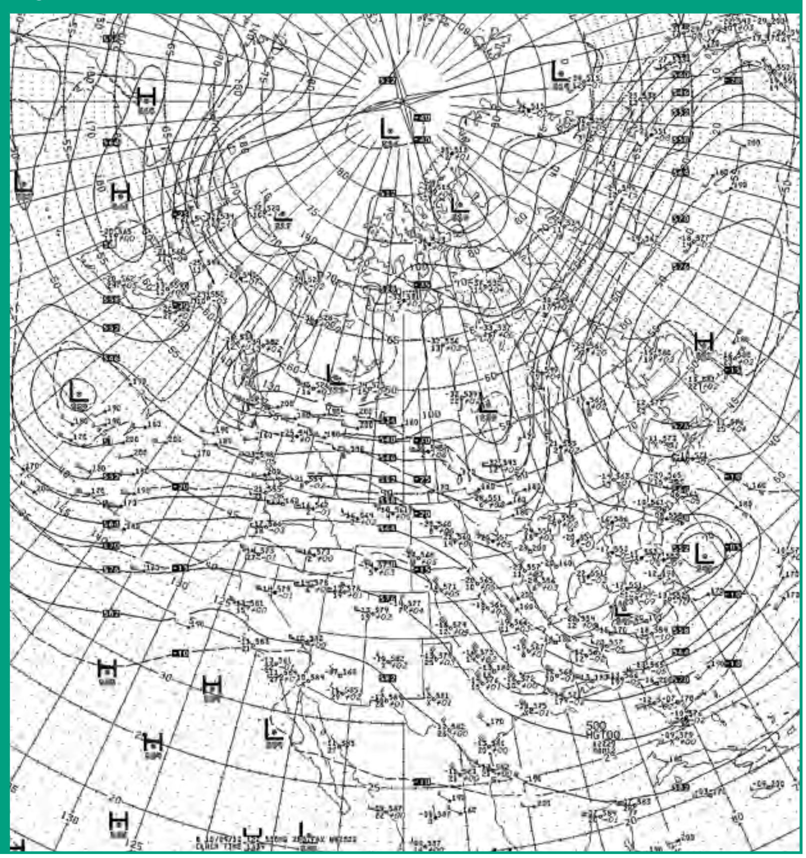


Figure 7

Figure 6



Images: U.S. National Oceanic and Atmospheric Administration

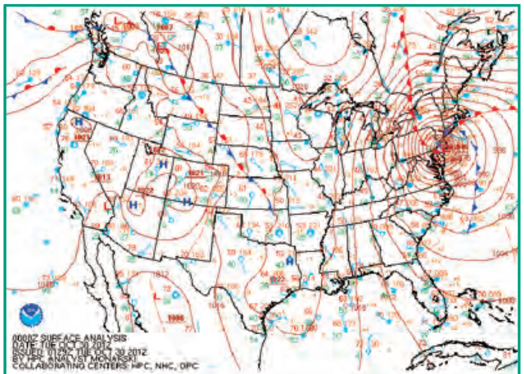


Figure 8

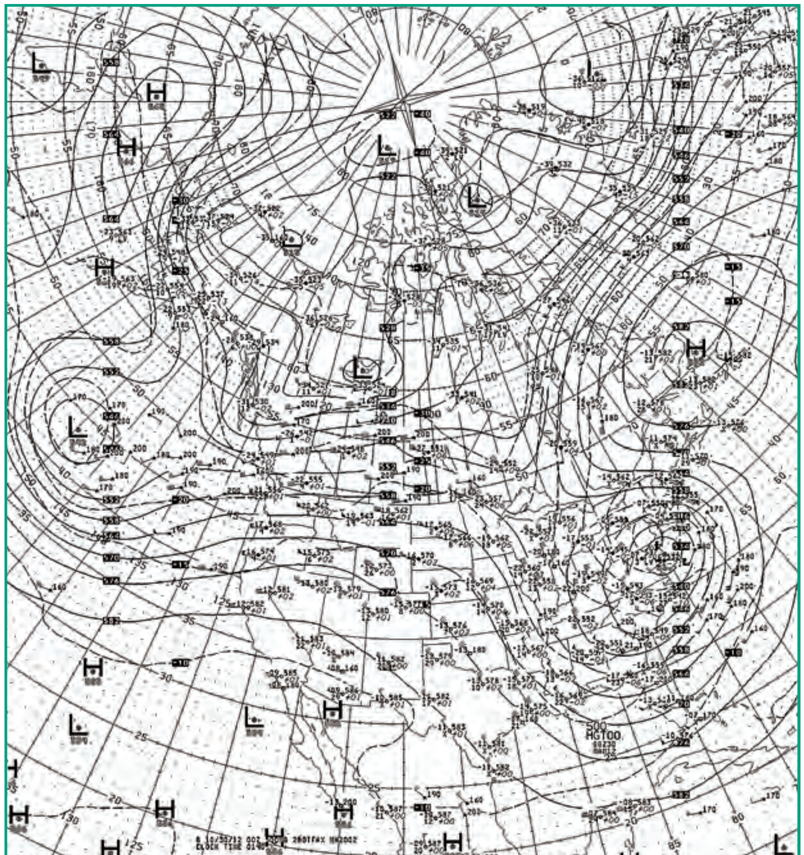


Figure 9

Images: U.S. National Oceanic and Atmospheric Administration

pulled to the west into the stronger system. Convection near Sandy's center continued to develop (Figure 7). The central pressure also continued to fall, reaching 940 mb by 2100 UTC. Sandy's hybrid nature was a double-edged sword. Had Sandy been a pure tropical hurricane, with such low pressure, it would have been a Category 4 hurricane with maximum sustained winds of 114 to 135 kt. Instead, winds were still holding near 70 kt, but the wind field was huge, with gale force winds now covering nearly 1,000 mi.

Sandy likely became a true extratropical cyclone just before it came ashore in southern New Jersey with maximum sustained winds of 70 kt and a central pressure of 946 mb (27.94 in Hg). The surface map for 0000 UTC on Oct. 30 (Figure 8) shows a fully transformed Sandy now associated with an array of fronts. In terms of pressure, Sandy was the strongest storm ever to make landfall this far north. Although winds of 70 kt ordinarily wouldn't produce an excessive storm surge, because of Sandy's huge size, it brought devastatingly high tides to the New Jersey and New York shorelines. The 0000 UTC 500 mb chart (Figure 9) shows that the two 500 mb lows have basically merged over eastern Maryland. Sandy's residual pool of warm air can be seen over eastern Pennsylvania and New Jersey.

Can these hybrid or transitioning cyclones be forecast? In the case of Sandy, the answer is yes. Computer models accurately forecast Sandy's intensity and even its point of landfall days ahead. Advance warnings saved lives. However, the property destruction and disruptions to airline service were unavoidable.

The precise forecasts helped prevent flight incidents associated with Sandy. It was easy to cancel flights and even close airports based on the accurate predictions. But these hybrid storms may not always be forecast that well. Errors in track or intensity predictions could result in little warning of dangerous flying conditions.

How is climate change involved in all this? Obviously, the earth is getting warmer. As the air and water warm, there will be more energy available for all types of storms. Another way to look at this: The purpose of storms (cyclones) is to transport energy on the earth, basically from the equator, where it's hot, to the poles, where it's cold. A warmer earth would mean more storms and potentially stronger storms. Sandy could just be a harbinger of things to come.

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

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BY WAYNE ROSENKRANS

Pan American *Style*

Regional aviation leaders share expertise and operational safety intelligence on managing risks of projected growth.

For Latin American and Caribbean airlines and their regulators, today's threats are far more alike than different compared with those facing airlines in other parts of the world, according to regional aviation specialists who also say flight data analysis and unprecedented sharing of information hold the key to further significant safety improvements.

Flight operational safety has no single owner; the responsibility for safety belongs to everyone on both the public and private sides of aviation, said Jaime Alarcón Pérez, director general of the Dirección General de Aeronáutica Civil of Chile (DGAC). That means, in effect, that every new initiative implies both sides working together with greater unity of purpose than ever. He was among presenters in October 2012 at Flight Safety Foundation's International Air Safety Seminar in Santiago, Chile.

Chile has followed the internationally accepted road map for all states in implementing a national program for operational safety in aviation, recently publishing version 2.0 of its integrated policy for aviation management, setting upgraded standards for air traffic service providers including a safety management system (SMS) rule, an SMS rule for airports, an SMS rule for aviation maintenance centers and an

SMS rule for other types of aviation businesses. Alarcón said phase one elements of the road map have been completed successfully, the second phase is in progress, and the final phase is slated to be done by the end of 2015. More than 50 SMS courses have been taught in Chile since 2006, and 32 percent of the 1,050 DGAC staff have attended so far, with 80 percent expected to be SMS-trained by 2015.

David McMillan, then director general of Eurocontrol and new chairman of the FSF Board of Governors, quoted Alarcón's characterization of the situation as an "explosion of growth" in both Chile and the region. "It's important to be sure that we deliver the safety which is necessary," McMillan said, comparing these circumstances with those in some other regions, such as Europe, now facing tough cost-cutting among airlines and air navigation service providers alike.

"The issue is how you … make sure that safety gets the resources it needs at a time when tough action is indeed being taken to address those costs," he said. "Europe has a great safety record. But as you know, it took a lot of work to get there, and it's extremely important not to fall into the trap of complacent thinking or to think that excellent safety practices can be sustained without effort."

Regional Aviation Safety Group

The Regional Aviation Safety Group–Pan America (RASG-PA), a government-industry partnership, was formed in 2008 in Costa Rica under the framework of the International Civil Aviation Organization (ICAO) *Global Aviation Safety Plan* and *Global Aviation Safety Roadmap* to support a performance-based aviation safety system.

Chile, which has not had a fatal accident involving a major air carrier in 24 years, inspires regional leaders to mitigate their key risks, said Loretta Martin, secretary of RASG-PA and regional director for ICAO's North America, Central America and Caribbean Regional Office, which encompasses 20 states and 12 territories.

According to ICAO definitions, Pan America had 52 accidents, including four fatal accidents, in 2011. The five-year moving average for the period ending in 2011 showed "basically, globally, that [the trend is] going down slightly and very slightly in the Pan America region," Martin said. RASG-PA currently focuses on "three main killers" that account for 73 percent of all accidents worldwide — runway excursions, loss of control–in flight and controlled flight into terrain (CFIT) — because of their equal regional relevance.

RASG-PA has promoted the use of standardized CFIT awareness training, tool kits for runway excursion reduction and runway safety teams; conducted research on go-arounds and mitigation of unstable approaches; added to flight training an advanced maneuvers manual and tool kits on pilot monitoring; conducted safety workshops; issued a runway-maintenance manual in conjunction with Airports Council International; and issued the first in a series of safety advisories, covering airplane automation mode awareness and energy state management risks.

"We had air navigation safety and aviation security, but until this group was established, we never quite had a forum for states together with industry to [focus on operational safety] — RASG-PA is it," said Oscar Derby, director general of the Jamaican Civil Aviation Authority and government co-chair of RASG-PA. The group especially has been strong in providing states with data-driven guidance on compliance with eight critical elements defined by ICAO and making the world's best information resources readily available — and mostly free of charge — through the group's website <www.rasg-pa.org>.

From the beginning, RASG-PA leaders realized that implementation of safety management systems was hampered by inadequate event reporting linked to absence of voluntary, nonpunitive reporting systems. "In some [legal] systems, if you make a report, it is mandatory that you be prosecuted for making the report," Derby said, "And so it took us three years to develop a legal framework that would suit the various legal systems and allow for the protection of safety

"It's extremely important not to fall into the trap of complacent thinking or to think that excellent safety practices can be sustained without effort."

information." This work has enabled the group to conduct training sessions and seminars that equip states to roll out this legal framework.

Derby cited regional versus global data on air transport accident rates.[1] "The 10-year moving average from 1990 through 2000 for all regions … was 1.2 [accidents per million departures]," he said. "The [Latin America and Caribbean region's comparable] 10-year moving average was 3.8. … In the 2010 10-year moving average, Latin America has made huge strides in moving that accident rate down [to 2.3], with the world rate going down to 1.0 per million."

Derby noted that RASG-PA has been acutely aware of the disparity in safety performance among operators of large commercial jets versus operators of turboprop airplanes in some parts of the region, and the group's issue analysis team soon will determine whether new targeted mitigations are warranted.

The group nevertheless has a few areas of concern. "One of them is infrastructure," said Alex de Gunten, executive director of the Latin American and Caribbean Air Transport Association (ALTA) and industry co-chair of RASG-PA. "We've got a major concern as to where … are we going to land [a much larger fleet of] airplanes in the next 20 years, because our airports are already saturated."

None of the region's airlines that participate in the International Air Transport Association (IATA) Operational Safety Audit (IOSA) program has had a fatal accident in four years, de Gunten said. "We've got a few priorities in the region, number one is IOSA. … If we look at the accident rate of IOSA versus non-IOSA [carriers] for Latin America over the last four years … the Latin American carriers are about the world average, actually slightly below the world average. But where you see a big jump is in the non-IOSA carriers, and this is an area that concerns us all. … We have a number of governments that have already taken IOSA as part of their certification and requirements; Chile is one of those countries, Brazil [is another]. However, we still need to make sure that we do not create two levels of aviation in the region."

RASG-PA and IATA in 2012 collaborated on data sharing and shared trend analysis. As of November, data from flights reflecting more than 80 percent of available seat kilometers have been collected in a new data exchange program, de Gunten said. A small related program has brought together a trusted regional team "working and sharing information, trend information to again identify opportunities, identify risks and mitigate them, and we have already had some very significant results in terms of changes of procedures, reductions of [traffic-alert and collision avoidance system alerts], etc., and a similar program is now also working in Brazil [and] Chile."

Among other issues vying for attention, despite ICAO's standards for pilot–air traffic controller phraseology, "we are not where we should be in the region based on a recent RASG-PA survey [of the two professions]," he said. "We … asked them if they knew the standard ICAO phraseology; about 31 percent said 'no.' We asked those who knew [it], 'Do you apply it 100 percent of the time?' and about another 25 percent said 'no.' … This is an area of concern."

Contrary to other presenters, de Gunten downplayed the anxiety seen among regional lawyers and some safety professionals about potential abuses of confidential safety information. Data-sharing initiatives so far are flourishing regardless of those fears "because at the CEO level of the airlines of ALTA, they strongly feel that the risk is much smaller than the benefits that we can get by sharing that data," he explained, and the gaps in protection often have been overcome by sheer creativity. "ALTA gathers the data, puts it together and shows it; we don't print it, we don't give it to the authorities because we're still not protected," he said. "They look at it, we work together, and then we go and we do our work."

Panama's Data-Sharing Emphasis

Despite an iceberg-size volume of advice floating around about SMS for air carriers, difficulty in practical implementation of the theories and processes can leave an airline with the sense that something essential is still "hidden below the waterline," said José Eduardo Rodríguez, a captain and director of safety and quality assurance for Copa Airlines. A year-long project at his company recently reviewed elements of its SMS — including nonpunitive safety reporting methods — in consultation with the Autoridad Aeronáutica Civil of Panama (AAC) and Flight Safety Foundation.

The current focus of the project is working closely with the pilot union, and subsequent phases will involve the remaining unions to encourage a strong voluntary reporting culture. "Trying to build [this] within the company is not an easy step," Rodríguez said. "It's something that takes time. It takes a lot of training from the organization, a lot of reception and trust from the rest of the coworkers." The only precedent had been mandatory occurrence reports.

Nonpunitive reporting also involves safety action groups in operational areas, with ultimate oversight by a safety review board, which keeps the CEO apprised of how risks are being managed inside the company and how accidents are being prevented. Goal-setting and a regulatory and internal structural framework for a related initiative called Pan American Voluntary Safety Information Program — involving a memorandum of understanding among the civil aviation authority, pilot union and Copa — recently have been in progress. First on the agenda will be analysis focused on a set of 300 events involving a loss of required air traffic separation, and steps to ensure that employees will trust the system enough to voluntarily submit reports to specialists who can update risk assessments. The agreement empowers the civil aviation authority to resolve disagreements.

The second phase of the project will extend this voluntary reporting to ramp operations staff, maintenance technicians and flight attendants. Protective measures have yet to be added to regulations, and for that reason, the company has partnered with the Panamanian authority to reconfigure the regulatory structure.

Currently, the airline presents a monthly report of safety data trend analysis, based on internal flight data analysis, to the AAC. As Copa is Panama's only air carrier, sharing of data or trend analysis within the country has not been possible. The company also participates in industry-level flight data sharing — for example, unstable approach data for six Central American airports through a program based in Costa Rica.

In November 2012, flight data monitoring specialists from Copa Airlines were scheduled to visit their counterparts at Copa Colombia and officials of the Aeronáutica Civil of

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Colombia. A good fit will be possible partly by replacing traditional management "silos" with horizontal, process-driven organizational structures under SMS, he said.

FOQA at LATAM Airlines Group

The 2012 merger of Chile's LAN Group and TAM Linhas Aéreas of Brazil required an intensive four-month process to use flight operational quality assurance (FOQA) to quickly identify and mitigate new risks associated with the gradual changes in flight operations, said Enrique Rosende Alba, corporate director of safety and security, LATAM Airlines Group.

Up-to-date FOQA technology and methods will help LATAM to meet publicly declared safety commitments and aspirations, Rosende said, while becoming the largest air carrier in the Latin America and Caribbean region. The new holding company has nine affiliate airlines operating 309 aircraft among 116 destinations in countries such as the United States, Mexico, Colombia, Ecuador, Peru and Argentina. Plans call for fleet expansion to approximately 500 airplanes around 2015.

Human errors will be understood as opportunities to improve operational safety, but constant emphasis will be

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placed on avoiding violations of company norms and standard operating procedures. He called operational safety the one "non-negotiable value" among four in the new holding company's values statement.

Given its mode of "permanent growth" in fleets and new routes, LATAM Airlines Group has been submitting each contemplated change to formal risk analysis, Rosende said. This was recently completed for Airbus A320 operations and was set to begin for Boeing 767 operations. The risk analyses extend to issues such as violations of regulations and operational policies on alcohol and drug consumption. During 2012 alone, more than 10,000 employees received corporate-level training on safety aspects of the holding company–related changes under way.

Analysts already have seen improvement in the incidence of unstable approaches — a noticeably inverse proportion to the increasing level of FOQA program monitoring and associated training of pilots.

Over the years, FOQA has been valuable from an operational efficiency viewpoint as well as in risk management, he said. One example has been monitoring the rollout of required navigation performance instrument approaches and verifying that flight crews use them as intended. Another example has been verifying crew compliance with "lean fuel" practices that the company desires and airframe manufacturers recommend.

Confidentiality of FOQA data is assured partly by a team that has centralized gatekeeper responsibility at an office at the holding company, collecting data from all the affiliate airlines. A few conditions in which data confidentiality can be terminated are specified by policy, such as a crewmember's repeated responsibility for the same type of event.

Almost Infinite Information

Systems to identify and mitigate unstable approaches have been refined significantly in the context of LATAM changes, Rosende said. A previously effective LAN Group method was judged unsuitable for meeting new demands. With multiple affiliates in mind, version 2.0 of the unstable approach program has been pilot-tested at the holding company level. Essentially, this FOQA analysis takes a deeper and finer look at parameters over a longer period of time during each approach.

This more accurate, TAM-derived process — beginning at 1,000 ft above ground level — is best suited for cross-affiliate comparison and aligned with industry best practices, Rosende said. Analysts already have seen improvement in the incidence of unstable approaches — a noticeably inverse proportion to the increasing level of FOQA program monitoring and associated training of pilots. The process inherently encourages pilots to improve, he said, and LATAM also is willing to share the lessons learned with other airlines through ALTA.

No related operational changes have had to be introduced to pilots, however. Adherence to existing SOPs and education of pilots about the more precise measurement have been sufficient. Beginning in January, LATAM expected to have this version 2.0 measurement process fully in place to help reduce unstable approaches.

Next on the agenda is concentration on hard landings, deep landings, rejected takeoffs and normal go-arounds — often involving operation of aircraft to/from relatively complex airports in the region, Rosende said. A preliminary look at one set of 46 hard landings, 34 unstable approaches and 59 deep landings actually found no variable in common between one event and another, reflecting the analytical challenges. Other current interests are mitigation of bird strike risks and in-flight shutdown of engines.

"We firmly believe that this information is valuable not only to operators but valuable to the aviation system," Rosende said. "Therefore, given the conditions we're in, we're predisposed to voluntarily deliver this information with the ultimate purpose that we all will win from the viewpoint of operational safety."

Note

1. Data represent ICAO-defined hull loss accidents, by airline domicile, involving Western-built transport airplanes with maximum takeoff weight of 60,000 lb (27,200 kg) or greater, and using known departures coupled with indirect estimates of missing departures data from maintenance logs.

BY RICK DARBY

C-FOQA Data Show Continued Improvement

As program participation increases, trends become more meaningful.

The annual rates of flight operations events, or predefined exceedances of selected parameters, continued to decrease in the most recent analysis of corporate flight operational quality assurance (C-FOQA) business jet data for the years 2006–2011 by Austin Digital C-FOQA Centerline.[1] Also notable was a reduction in the rate of unstable approach events in 2011, to the lowest level in the six-year period.

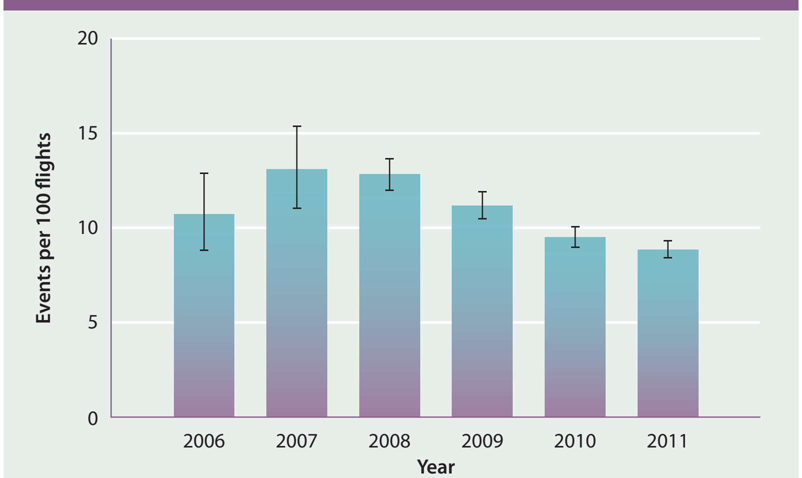
The trend was particularly encouraging because of growth of participation in the program, with these flights and events making the data even more statistically relevant to this industry sector. While event rates continue to decline overall, there is still concern that go-arounds following unstable approaches are not being conducted, and there is persistent evidence of high-energy approaches, both of which are strongly associated with runway excursion events as shown in the 2009 briefing of the Runway Safety Initiative coordinated by Flight Safety Foundation.

Exceedances represent cases when an event's parameter data are considered less than optimal for safe operation. For example, during approach, C-FOQA analysis flagged an exceedance if the flight data recorder showed that the aircraft was above or below the glideslope, or was out of alignment with the localizer, in each case by a stipulated deviation. It also tagged an event, for another example, if the ground-proximity warning system (GPWS) produced a "sink rate" or "pull up" warning at certain altitudes and rates of descent. Events were categorized under the headings of unstable approach, flight operations, risk monitoring, aircraft limitations and aircraft systems.

During 2010 and 2011, flight operations event rates have been under 10 per 100 flights, with an improving trend since 2007 (Figure 1). The length of the error bars has also been decreasing.[2]

For risk reduction in flight operations — as in other event categories — it is important not only to know the rate of events, but what kind of events they were. This offers a clue to the relative prominence among the event types that might be accident precursors. In 2011, the highest rate — nearly double the next highest — involved GPWS glideslope alerts below 3,000

C-FOQA Annual Flight Operations Event Rates, 2006–2011



C-FOQA = corporate flight operational quality assurance

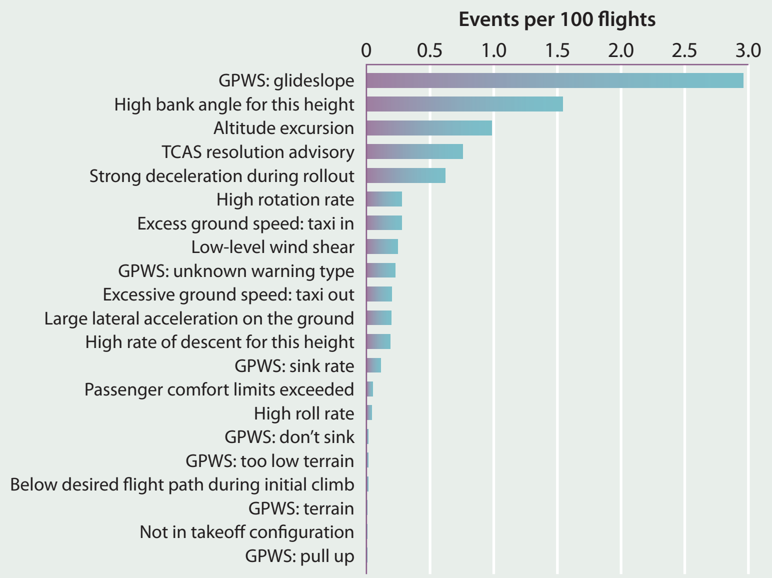
Note: Error bars are calculated with a 90 percent confidence interval.

Source: Austin Digital C-FOQA Centerline

Figure 1

ft radio altitude (Figure 2). Analysis discovered that most of the glideslope excursions revealed a tendency to "duck under" during very short final. This was supported by the average threshold crossing height of 36.1 ft, somewhat lower than the target height of 50 ft.

C-FOQA Flight Operations Event Rates, by Type, 2011

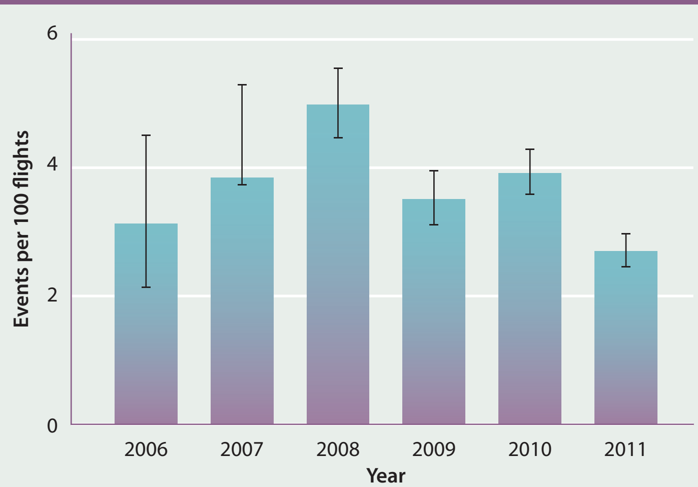


C-FOQA = corporate flight operational quality assurance; GPWS = ground-proximity warning system; TCAS = traffic-alert and collision avoidance system

Source: Austin Digital C-FOQA Centerline

Figure 2

C-FOQA Unstable Approach Event Rates, 2006–2011



C-FOQA = corporate flight operational quality assurance

Note: Error bars are calculated with a 90 percent confidence interval.

Source: Austin Digital C-FOQA Centerline

Figure 3

Other relatively common events included bank angle exceedance, altitude excursion, a traffic-alert and collision avoidance system resolution advisory lasting more than two seconds, and exceedance of expected deceleration during rollout.

Annual unstable approach event rates in 2011 decreased notably from those of 2010 and were the lowest in the 2006–2011 data set (Figure 3).[3] These events, unlike flight operations events, showed no discernible trend during the five previous years of the C-FOQA program. For all program years aggregated, the highest rate of unstable approaches occurred in the third quarter — July, August and September.

Considering types of unstable approach events, the highest rate in 2011 was for flying above the glideslope, only slightly less frequent than events involving being fast on the approach (Figure 4). Of those flights when the approach was flown above the glideslope, nearly half were between 0.00 and 0.25 dots high. About 0.3 percent of the flights were between 2.00 and 2.25 dots high, past the caution limit, and the greatest deviation — about 0.1 percent of the flights — was 3.50 dots high or more. Of greater concern is that four of the top five unstable approach event causes indicated high-energy approaches, strongly associated with runway excursions.

Preliminary analysis of unstable approach events correlated with both time of day for the event and length of the runway have been introduced. The aggregate data are statistically irrelevant at this point; however, individual operators now have the ability to look more closely into their own operations, where event rates may be more statistically relevant.

Risk monitoring events concerned alerts or cautions for threats such as fuel exhaustion, controlled flight into terrain (CFIT), stall, landing overruns, hard landing and tail strike. The highest rates in 2011 were for CFIT risk and risk of a landing overrun (Figure 5).

C-FOQA Centerline says that it is now working to provide pilots with more detailed information concerning the risk of landing overrun events by offering analysis of landing performance for the first time. That includes monitoring threshold crossing height, airspeed at threshold, float distance, tailwind at threshold and runway remaining when slowed to 80 kt. These events will be combined to provide analysis of the newly drafted stabilized landing concept.

Event rates in 2011 that exceeded the aircraft's recommended operating limits tended to be low; those events primarily consisted of calibrated airspeed beyond the aircraft model's flap speed limit, based on the aircraft's reference flight manual. That occurred slightly more than 0.7 times per 100 flights. C-FOQA Centerline says its data suggest that flap overspeed events generally decline markedly after the first two years in the program when flight departments take measures to reduce them.

All the other measured operating limits exceedances occurred less than 0.2 times per 100 flights.

Aircraft system events for 2011 were negligible in number except for selecting or maintaining reverse thrust while decelerating at relatively slow speed.

Participation in the C-FOQA program has grown steadily since it was initiated in 2006 (Figure 6, p. 50). In 2011, more than 10,000 flights contributed data, for a total of more than 30,000 flights since the program's origin. Twenty-five operators participated in 2011, with the data representing 73 aircraft of 16 types or variants.

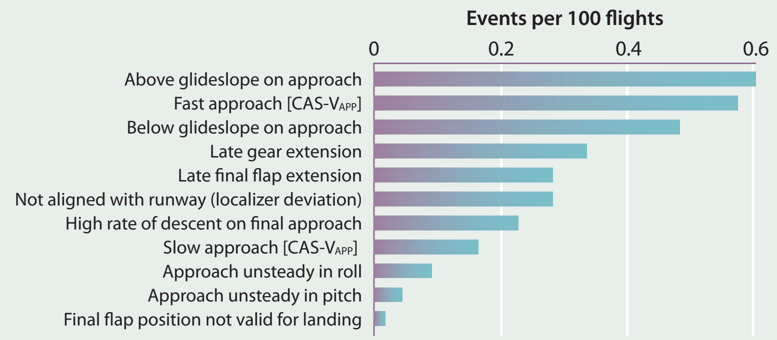
Pilot Fatigue Barometer

The European Cockpit Association, which represents national pilot associations of 37 European states, has summarized the results of surveys conducted by some of its members in a report titled "Pilot Fatigue Barometer."[4] The surveys were carried out between 2010 and 2012 in Austria, Denmark, France, Germany, the Netherlands, Norway, Sweden and the United Kingdom. Some 6,000 pilots responded to queries about how fatigue affected their flying performance.

Mentioning several well-known accidents in which pilot fatigue was cited as a causal factor, the report also suggests that fatigue often goes unreported in accidents and incidents — first, because pilots are reluctant to admit flying "under the influence" of fatigue out of concern it could provoke punitive action by an employer or even criminal prosecution; second, if the pilots happen to be killed in an accident, fatigue leaves no material evidence.

The main potential consequences of fatigue during flight duty include degradation of thought processes, perception and reaction time; periods of unintended sleep; and momentary "micro-sleep." Percentages of pilots who reported having experienced fatigue in the cockpit ranged from 93 percent of those in the Denmark survey to 45 percent who responded to the U.K. survey. Pilots who said they had dozed off or had a spell of micro-sleep ranged

C-FOQA Unstable Approach Event Rates, by Type, 2011

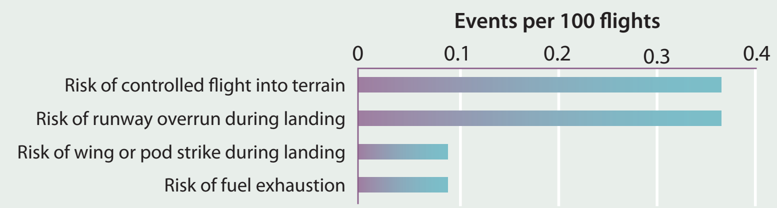


C-FOQA = corporate flight operational quality assurance; CAS = calibrated airspeed; V_{APP} = approach speed

Source: Austin Digital C-FOQA Centerline

Figure 4

C-FOQA Risk Monitoring Event Rates, by Type, 2011

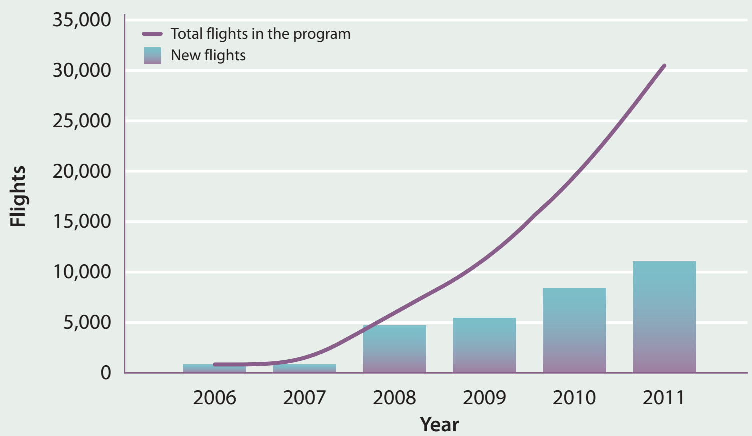


C-FOQA = corporate flight operational quality assurance

Source: Austin Digital C-FOQA Centerline

Figure 5

C-FOQA Participation, 2006–2011



C-FOQA = corporate flight operational quality assurance

Note: As of end of year 2011, 73 aircraft of the following types contributed to the data set: Boeing BBJ, Bombardier Challenger 300, Bombardier Challenger 604, Bombardier Challenger 605, Bombardier Global Express, Bombardier Global Express XRS, Cessna Citation X, Dassault Falcon 2000EX, Dassault Falcon 900DX, Dassault Falcon 900EX, Dassault Falcon 7X, Embraer ERJ-135, Gulfstream G450, Gulfstream G550, Gulfstream GIV and Gulfstream GV.

Source: Austin Digital C-FOQA Centerline

Figure 6

from 54 percent of respondents from Sweden to 10 percent of those from France. The report did not speculate on the reasons for the national differences among responses.

"More than three out of five pilots in Sweden (71 percent), Norway (79 percent) and Denmark (80–90 percent) acknowledge [having] made mistakes due to fatigue, while in Germany it was four out of five pilots," the report says.

Responses indicated that 92 percent of German pilots reported that they had felt "too tired" or "unfit" for duty on the flight deck at least once in the previous three years. In the Austrian pilot association, 85 percent of respondents reported that they had been too fatigued for flight duty but nevertheless had reported for their assignments. Two-thirds of those said they had flown under that condition more than once. Swedish and Danish pilots reported similar percentages.

"According to the surveys among pilots, night flights or a series of night flights are major contributors to fatigue," the report says. "For example, in France, almost 70 percent of the pilots identify night flights as a cause of fatigue. Nearly half of the respondents in Germany agree that night flights are one of the major causes of pilot fatigue. …

"The study among British pilots shows that fatigue prevalence is associated with the number of sectors, flying and duty hours or [the commander's decision making] frequency."

Other identified causes included a series of morning departures; insufficient rest between duty periods; being recalled from standby status; and inadequate rest accommodations.

Nevertheless, the report says, only 20 to 30 percent of the pilots polled reported that they had acknowledged feeling unfit for duty. "Such under-reporting of fatigue has been confirmed by an independent survey of 50 U.K. aviation medical examiners in April 2011," the report says. "The vast majority (70 percent) of the aviation medical examiners believe that pilots are reluctant to report fatigue within their company."

About a third of the pilots who chose not to file fatigue reports gave as their reason that they were too tired at the end of an exhausting workday.

Notes

1. The C-FOQA User's Group — comprising all program participants — is led by a steering committee plus Austin Digital, Flight Safety Foundation and other external parties.
2. Austin Digital explains the meaning of error bars: "When displaying event rates (e.g., events per 100 flights), it is appropriate to compute proportion confidence intervals — error bars — along with the raw event rate. These bars indicate a range, based on the number of flights sampled, within which the true rate likely falls with high confidence. In general, the larger the sample of data (i.e., more flights), the smaller the error bar will be and the more confident you can be that the resulting rate is a statistically significant value."
3. Unstable approach criteria are aligned with the elements published by Flight Safety Foundation, which include nine requirements, all of which must be satisfied. The criteria also specify that flights must be stabilized by 1,000 ft above airport elevation in instrument meteorological conditions and by 500 ft above airport elevation in visual meteorological conditions. *FSF ALAR Tool Kit*, Briefing Note 7.1, <flightsafety.org/files/alar_bn7-1stablizedappr.pdf>.
4. <www.eurocockpit.be/sites/default/files/eca_barometer_on_pilot_fatigue_12_1107_f.pdf>.

SMS Under the Microscope

Has the safety management system concept been 'oversold'?

BY RICK DARBY

REPORTS

Opinion Versus Evidence

A Systematic Review of the Effectiveness of Safety Management Systems

Thomas, Matthew J.W., and Westwood-Thomas Associates. Australian Transport Safety Bureau (ATSB). 46 pp. Figures, tables, references, appendix. November 2012, updated Dec. 10. Available at <www.atsb.gov.au/publications/2012/xr-2011-002.aspx>.

Safety management systems (SMS) have a vast amount of academic management theory behind them, and their principles seem logical. While there is some variation in views of the components of an SMS, they generally include identification of safety hazards; remedial action to reduce those hazards; continuous monitoring of safety performance; and continuous improvement of the SMS itself. SMS might be said to represent a fundamental conceptual change in risk management. The emphasis shifts from compliance with reactive, externally generated procedures and regulations "written in blood" — that is, based on costly lessons from accidents — toward internal analysis of hazards uncovered in normal operations. Accident causal factors can be anticipated and, as far as possible, mitigated before they do their worst.

It is an exciting prospect, with a touch of magic. We can take charge of the future rather than just waiting to see what it throws at us. SMS has been enthusiastically adopted by operators and regulators.

For example, this ATSB report cites an Australian Civil Aviation Safety Authority (CASA) document that it says "dedicates a whole appendix to 'selling' the benefits of an SMS." Among the suggested benefits of an SMS are a reduction in incidents and accidents; reduced direct and indirect costs; safety confidence among the traveling public; reduced insurance premiums; and proof of diligence in the event of legal or regulatory safety investigations.

But science insists: *Prove it.*

That, it turns out for the authors of this ATSB report, is a tall order. Their report says, "Unfortunately, [the CASA document] appendix makes no reference to any scientific evidence to support these claims, nor legal evidence with respect to due diligence. Indeed, much of the regulatory effort with respect to the adoption of SMS as the primary regulatory platform has been characterised on uncritical acceptance, and based on expert opinion and face validity, rather than subjected to formal scientific validation.

"Previous published reviews of SMS research do not appear to provide strong empirical evidence to support the specific benefits of adopting an SMS. For instance, the summary of a 2006 review of evidence for the effectiveness of SMS across a wide cross-section of industries suggests that there has been a 'less than expected' reduction in accident occurrence since the implementation of SMS." (References can be found in the original report.)

ATSB commissioned Matthew Thomas and Westwood-Thomas Associates to undertake a meta-analysis of SMS research. The authors began with a comprehensive search of the literature and found 2,009 articles, a promising start. However, the great majority of the sources washed out because of rigorous inclusion criteria. Among other requirements were that only peer-reviewed articles published between 1980 and 2012 were accepted; studies "must have clearly defined a research question that related to the effectiveness of safety management systems, or specific components of a safety management system"; studies must have defined effectiveness in terms of safety-related outcomes, rather than other standards such as improved productivity; and studies must have reported quantitative measures. There was also a quality appraisal based on published guidelines for methodological soundness.

Ultimately, 37 papers were determined to be directly relevant to the objectives of the investigation. However, "only 14 [studies] involved an SMS designed to avoid low-probability/high-consequence (LP-HC) accidents" — one way of looking at aircraft accidents — "with the remaining 23 studies relating to work health and safety," the report says. "In addition, very few of these studies were undertaken in transport domains, and many studies only measured subjective perceptions of safety rather than objective measures. The limited [amount of] quality empirical evidence available relates to the difficulty of measuring objective safety improvements in industries where the SMS is aimed at avoiding LP-HC accidents and the relative recency of the application of SMS."

Even among the 37 papers accepted for analysis, the study's authors were less than fully satisfied with the quality of evidence. Only a single study met the scientific "gold standard," a randomized, controlled trial. Of the 37 articles included in the systematic review, 19 used objective measures of safety performance. And 15 of the 19 related to workplace health and safety, using such metrics as occupational injuries to workers. "Of these studies, the majority demonstrated significant positive effects with respect to dimensions of SMS," the report says. "A number of studies found general relationships between SMS implementation and safety performance."

Eighteen of the 37 articles analyzed in the systematic review used only subjective, self-reported measures of safety performance, most with a survey-based methodology in which both individual perceptions of effectiveness of SMS components and safety metrics were subjective.

The report notes, however, that across multiple studies, there was scant agreement about which components of an SMS individually caused change in safety performance.

The four studies of L-P/H-C industries, probably the most relevant to aviation, demonstrated "no consistent findings … with respect to performance on various dimensions of an SMS and poor safety outcomes. …

"Several studies explored the relationships between components of SMS and

'Previous published reviews of SMS research do not appear to provide strong empirical evidence to support the specific benefits of adopting an SMS.'

While an association may be found between an SMS 'model' and better safety-related behavior, it is not clear whether a causal relationship exists.

safety performance in the context of major hazard facilities. The first of these studies from an oil refinery environment established a relationship between self-reported safety performance and the two components of (1) management commitment and (2) safety communication. A second study, undertaken by the same authors, found no direct effect of management commitment, but rather (1) supervision, (2) safety reporting and (3) team collaboration as the immediate drivers of safe work practices.

"Slightly different findings were obtained in another study, whereby (1) management commitment and (2) safety rules and procedures were found to be directly associated with safe work practices in major hazard facilities in India."

One study seemed to offer some evidence of what factors were effective in improving safety performance. "This study, within the maritime domain, found that safety behaviour was influenced by safety policy and perceived supervisor behaviour rather than other components of safety management systems," the report says. The authors of that study concluded that "shipping companies should therefore invest large amounts of money in developing and implementing safety rules, procedures and training."

The report says, "In perhaps one of the most important studies [published in 2008] in terms of relevance to high-risk transport industries (using a cross-section of industries), there was no real relationship established between everyday safety performance and L-P/H-C events. This finding from the U.S. highlights the lack of clarity in what might actually be driving ultra-safe performance, and in many respects, the question as to SMS effectiveness is unable to be adequately answered by even the most recent research."

The report questions the validity of surveys and structural equation modeling — a statistical technique used to explore the relationship between a number of different factors, and their relationship to a particular outcome — in this research context. Using such a methodology, it says, "to tease out the inter-relationships between components of safety management systems, safety climate factors and safety performance might not assist in clarifying the complex set of factors influencing safety performance, and does not really assist in enhancing our understanding with respect to establishing the effectiveness of SMS."

A particular problem with surveys and self-reporting is that they "fail to utilise a standard set of instruments, thus leaving the industry unsure of exactly what is being measured. Furthermore, there is a tendency to infer causality from the findings of these models, inasmuch as increased management commitment *leads* to reduced rates of safety occurrence. No such directional causality can be inferred through these study designs, and … each of these studies is limited from the perspective of common method variance."

In other words, while an association may be found between an SMS "model" and better safety-related behavior, it is not clear whether a causal relationship exists. And if one does, it has been impossible to determine if the causal factor is one element of SMS, more than one element or the SMS in its entirety. Another way of looking at the data, as suggested by the maritime study, is that *management commitment* rather than SMS is the active ingredient.

Textbooks about worker behavior invariably discuss the "Hawthorne effect," derived from a series of studies conducted at the Western Electric Hawthorne Works in Cicero, Illinois, U.S., beginning in the 1920s. Experimenters tested the effect of increasing or decreasing the lighting in the employees' work environment, as well as other variables, on productivity. The researchers found that productivity improved with any change, even if it was only reversion to a previous condition. Their eventual conclusion was that the output improved either because the employees were aware that they were being studied or because managers seemed to care about the quality of their working environment.

Although, as with most scientific studies, the conclusions about the Hawthorne effect have since been questioned, it is generally accepted that observation affects behavior and doesn't merely measure it. So perhaps part of the reason for safety improvement attributed to SMS — if there is objective improvement — is that the SMS is on everyone's mind, more than any theoretical content of the system.

The report concludes with some thoughts about the "frameworks," "models" and "strategies" that have been upgraded in status to SMS. It says:

"There is a well-known axiom that states, 'there was never a randomised control trial for the effectiveness of the parachute.' This is to say that there has never been a study in which one group jumps from an aeroplane with a parachute, and their survival is compared with a group that jumps in exactly the same conditions, but without a parachute.

"The argument here is simple: Some interventions just do not require large-scale experiments to establish their effectiveness. Many interventions are based on first principles, that are things that we already know to be true, and logic. Safety management systems contain many of these elements. For instance, logic simply dictates that if you are to prevent the reoccurrence of an event, you need to understand what caused the event, and put in place strategies such that those causes are prevented from occurring again. Hence, the need for accident investigation is a simple logical necessity that requires no empirical evidence to support its use within safety management processes.

"This review of the scientific literature suggests that this logical necessity, which many might call 'common sense,' has driven much of the development of safety management systems."

If so, an SMS is a codification of principles learned through experience, an evolution rather than a revolution.

The report suggests another concern, which is that "it just might be the case that the ever-growing list of components of a safety management system may well result in dilution of effort across the spectrum of safety management activities. This dilution of effort may well result in poorer safety performance as the critical components receive less time and effort at the expense of yet another 'good idea' dressed up as a legitimate safety program. Given that, at present, there is no clear objective empirical evidence as to whether there are any critical elements, this is a real possibility."

Scientists, however, have a saying that "absence of evidence is not evidence of absence." Given the practical methodological difficulties of studying SMS, it is not surprising that demonstrating its effectiveness remains beyond current findings. It would be a rare flight operations department that would agree to deliver the presumed benefits of an SMS to half its operations while denying them to the other, "control" half — particularly because the system represents a continuing process, not a quick fix.

The report concludes, "Even within a vacuum of evidence, the precautionary principle states that we must not fail to take precautionary action. To this end, it is likely that the current regime of an aggregate set of components assembled into something, which we call a 'safety management system,' remains an important tool in the management of safety."

From Strategy to Action

2012 European Strategy for Human Factors in Aviation

European Human Factors Advisory Group (EHFAG). First issue, Sept. 1, 2012. 8 pp.

A European Human Factors Strategy has been developed by the EHFAG in conjunction with the European Aviation Safety Agency (EASA). "The strategy sets out to achieve two principal functions," this report says. "First, to foster consistency in the integration of human factors principles in the regulation, governance, system design, training, licensing, audit and assurance of aviation activities. Second, it outlines how the practical understanding and application of human factors can serve in enhancing safety performance across the aviation safety system. The strategy serves as a framework document to support the European Aviation Safety Plan (EASP)."

The strategy encompasses Europe's aviation system as a whole — "rule makers, authorities, investigators, researchers, service providers, industry and other stakeholders."

Lessons should be learned and shared from many sources, including accident investigations, data analysis and operational experience.

The EHFAG has significant input to EASA rules and advisory materials, and in turn, the EASA rules affect operators around the world. For example, there are about 6,000 repair stations with U.S. Federal Aviation Regulations Part 145 certificates. About 1,300 of those, mainly the larger U.S. repair stations, are EASA-certificated. Many technicians working in the United States are following EASA rules.

The EHFAG describes its guiding principles:

- "Providing appropriate governance and leadership — This would include consideration of appropriate HF [human factors] expertise within the regulatory organisations."
- "Developing a balanced regulatory structure — Human factors principles will be addressed in all the aviation regulations, whilst recognising the need for the regulation to be proportionate with an appropriate balance between rule, acceptable means of compliance (AMC) and guidance material."
- "Providing guidance and interpretive material — Adequate tools, guidance and AMC material to help industry apply human factors principles will be provided. [Material] will help regulators oversee the effective implementation of human factors by industry and in incident and accident investigations."
- "Promoting the importance of human factors — At a European level through the EASA website, regular newsletters and bulletins, and EASA conferences; at a national level through the cascading of EASA promotion and national conferences."
- "Coordinating activities — across organisations, including regulatory organisations, to avoid the transfer of risk from one domain to another. This coordination should be across both European and non-European aviation systems (e.g., with FAA [U.S. Federal Aviation Administration]). This should also include coordination with other safety organisations and initiatives such as the European Strategic Safety Initiative; Advisory Council for Aviation, Research, Innovation in Europe; Eurocontrol; and the implementation of safety management systems. EASA and the EHFAG should seek opportunities to influence and coordinate human factors with international bodies such as ICAO [International Civil Aviation Organization]."

Lessons should be learned and shared from many sources, including accident investigations, data analysis and operational experience, the report says.

The EHFAG's next step will be to develop an action plan from the strategy, converting it into a detailed human factors program by the end of June 2013. "Priority of tasks and actions will be based on the impact to the overall improvement of safety performance," the report says. An appendix lists specific components of the action plan under several headings, such as "training and competency" and "regulation and rulemaking."

Fatal Flight Test

G650 pilots received no warning of an incipient stall during a takeoff-performance evaluation.

BY MARK LACAGNINA

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

JETS

'Aggressive Schedule' Cited

Gulfstream G650. Destroyed. Four fatalities.

The manufacturer's "persistent and increasingly aggressive attempts to achieve V_2 [takeoff safety] speeds that were erroneously low" and its "inadequate investigation" of previous uncommanded rolls during takeoff performance tests were among the probable causes of the accident that killed all four crewmembers during certification flight testing of the Gulfstream G650, according to the U.S. National Transportation Safety Board (NTSB).

The accident occurred at Roswell (New Mexico, U.S.) International Air Center the morning of April 2, 2011. The flight crew was conducting a simulated one-engine-inoperative (OEI) takeoff and was not able to correct an uncommanded roll that occurred when the right wing stalled on liftoff. The wing tip struck the runway, and the experimental ultra-long-range, fly-by-wire business airplane veered right, struck a concrete platform housing electrical equipment and was consumed by a fuel-fed fire. The pilots and both flight test engineers succumbed to smoke inhalation and thermal injuries.

Flight testing that day, as well as during several previous tests, had focused on achieving the manufacturer's target for V_2, basically the minimum speed that a transport category airplane must attain at a height of 35 ft to meet the required OEI climb gradient to 400 ft. The V_2 speeds achieved during the tests had consistently been too high to meet the manufacturer's goal of providing a balanced field length of 6,000 ft (1,829 m).

Various rotation techniques and angle-of-attack (AOA) targets had been tried by Gulfstream Aerospace's flight-test crews, but none had succeeded in meeting the target V_2 without exceeding the 20-degree pitch angle that had been set to assure passenger comfort. The most recently developed technique included an abrupt and rapid rotation, using the maximum allowed 75 lb (34 kg) of pull force on the control column, to an initial 9-degree pitch attitude, then a further increase in pitch attitude to achieve V_2. This technique had produced the best results, exceeding the target by only 3 kt.

However, in the course of about a dozen test flights earlier the morning of April 2, the pilot-in-command (PIC) had decided that a smooth rotation, pausing only briefly at 9 degrees before increasing pitch to about 16 degrees, might be a better and more repeatable technique. "I'm not doing that jerk stuff," he told a flight test engineer. "It doesn't work … and I don't think the FAA [U.S. Federal Aviation Administration] is going to like it, either. It's such a great-flying airplane, you shouldn't have to abuse it to get [it] flying."

The NTSB report noted that both flight crewmembers had extensive experience as test pilots. The PIC had 11,237 flight hours, including 263 hours in G650 certification testing. The second-in-command (SIC) had 3,940 flight hours, including 140 hours in type.

During some of the earlier test flights that morning, the use of a smooth rotation with a brief pause at 9 degrees produced V_2 speeds within 4 kt of the target (135 kt). The pilots agreed to try an even briefer pause at 9 degrees during the next takeoff, which was conducted on Roswell's Runway 21 with flaps extended 10 degrees. As planned, the SIC moved the right thrust lever to idle at 105 kt, simulating an engine failure. At 127 kt, the PIC began rotating the airplane for takeoff. Recorded flight data indicated that there was no pause when the pitch attitude reached 9 degrees. AOA quickly exceeded 11 degrees, the outboard section of the right wing stalled, and the airplane rolled right. The PIC attempted to level the wings, but the bank angle increased beyond 16 degrees.

Because of a miscalculation of the G650's stall AOA in ground effect, the threshold for activation of the stick shaker and the primary flight display pitch-limit indicators had been set too high.

The pilots had received no warning of the asymmetric stall. Because of a miscalculation of the G650's stall AOA in ground effect, the threshold for activation of the stick shaker and the primary flight display pitch-limit indicators had been set too high. "Ground effect refers to changes in the airflow over the airplane resulting from the proximity of the airplane to the ground," the report explained. "Ground effect results in increased lift and reduced drag at a given [AOA], as well as a reduction in the stall AOA."

The stick shaker activated and the indicated pitch attitude reached the limit shown on the primary flight displays only after the stall occurred. The PIC pushed the control column forward, applied full left control wheel and rudder, and called for "power." The SIC already had moved the right thrust lever full forward. Despite these inputs, the airplane remained in a stalled condition. The sound of an automatic warning when the right bank angle exceeded 30 degrees was captured by the cockpit voice recorder shortly before the recording ceased about 24 seconds after the takeoff was initiated.

The report noted that uncommanded rolls resulting from right outboard wing stalls had been encountered during two previous test flights. In both cases, the pilots recovered by reducing AOA. The events subsequently were attributed to stalls induced by over-rotation. "If Gulfstream had performed an in-depth aerodynamic analysis of these events shortly after they occurred, the company could have recognized before the accident that the actual in-ground-effect stall AOA was lower than predicted," the report said.

Investigators found that the stall precipitating the accident had occurred at an AOA of 11.2 degrees, or about 2 degrees lower than the predicted stall AOA in ground effect.

The report said that contributing to the accident was the manufacturer's "aggressive" flight-test-program schedule, which was designed to achieve certification of the G650 by the third quarter of 2011. "The schedule pressure … led to a strong focus on keeping the program moving and a reluctance to challenge key assumptions."

The report noted that after the accident, Gulfstream suspended performance flight testing and implemented several corrective actions. The target V_2 was increased by 15 kt, while maximum takeoff thrust was increased by 5 percent to meet the takeoff performance goals. Certification of the new airplane eventually was achieved in September 2012.

The accident investigation generated 10 safety recommendations, including the NTSB's call for the FAA to work with the independent Flight Test Safety Committee to develop detailed guidance for aircraft manufacturers on flight test operations (*ASW*, 11/12, p. 15).

Illness Prompts Diversion

Boeing 777-200. No damage. No injuries.

More than an hour after the airplane departed from Paris for a flight to New York the morning of Jan. 17, 2011, the captain became ill. A physician among the passengers diagnosed gastroenteritis and applied basic antispasmodic treatment, after which the captain decided to continue the flight, said the report by the French Bureau d'Enquêtes et d'Analyses.

About 90 minutes later, the captain felt abdominal pain. "The doctor observed that the captain was very pale, with stiffness, shaking and severe pains in the abdominal region," the report said. The copilot declared an emergency and diverted the flight to Keflavik, Iceland. "During the descent, an improvement in the captain's condition allowed him to assume the duties of PNF [pilot not flying]," the report said. The airplane was landed without further incident.

The captain was taken to a hospital, where he was observed and released the same day. "The investigation could not determine the exact nature of the captain's pains," the report said.

Microburst on Short Final

Airbus A340. Substantial damage. No injuries.

Visual meteorological conditions (VMC), with winds from 360 degrees at 5 kt, had been reported at Darwin (Northern Territory, Australia) Airport the night of Feb. 28, 2012, but, while completing the instrument landing system (ILS) approach to Runway 29, the flight crew saw heavy rain close to the threshold.

The crew asked the airport traffic controller for an update on the weather conditions. The controller replied that there was a storm extending to the east from the runway threshold but that the reported wind was still from 360 degrees at 5 kt. The Australian Transport Safety Bureau (ATSB) report noted that the wind data were derived from sensors located about 2.3 km (1.2 nm) from the threshold.

"The crew briefed the possibility of a missed approach if the conditions deteriorated," the report said.

Rainfall increased as the aircraft neared the runway. The crew set maximum continuous thrust to arrest an increased sink rate encountered at 55 ft above ground level (AGL) but then reduced thrust to idle shortly thereafter. "As the aircraft entered the flare, the rain intensified, significantly reducing visibility," the report said.

The A340 touched down hard, with a recorded vertical acceleration of 2.71 g. None of the 116 passengers and eight crewmembers was hurt, but subsequent engineering inspections disclosed a broken engine mount and damage requiring replacement of several main landing gear components.

The report said that analyses of recorded flight data indicated that the aircraft might have encountered a downburst, an intense localized downdraft. The data showed that just before touchdown, the wind had changed from a 9-kt headwind to a 6-kt tailwind. "At touchdown, the tailwind was recorded at 18 kt, and the rate of descent was 783 fpm," the report said.

Fuel Leak Causes Fire

Boeing 767-300. No damage. No injuries.

The 767 was climbing through 9,000 ft after departing from New York's John F. Kennedy International Airport (JFK) for a flight to Haiti with 201 passengers and 12 crewmembers the morning of Feb. 8, 2012, when the flight crew heard a bang that was immediately followed by warnings of a fire in the right engine.

The crew shut down the engine and discharged a fire bottle into the right nacelle. The fire warning persisted until the crew discharged the second fire bottle, the NTSB report said. They declared an emergency and turned back to JFK. The first officer flew the airplane while the captain and standby first officer completed the associated checklists and communicated with the flight attendants. The crew then landed the airplane without further incident.

Subsequent examination of the 767 revealed no damage from the fire or the overweight landing. Investigators found that during maintenance the night before the incident, a bracket and spray shield for the integrated drive generator's fuel-oil heat exchanger had been reassembled incorrectly. "A seal under the fuel tube flange that is held in place by the bracket had the O-ring partially missing, which was the source of the fuel leak," the report said. "Contributing to the cause of the fire was the 767 Aircraft Maintenance Manual's lack of any graphical or pictorial displays of the correct assembly of the two-piece bracket and spray shield."

During maintenance the night before the incident, a bracket and spray shield for the integrated drive generator's fuel-oil heat exchanger had been reassembled incorrectly.

Head-On Over the Atlantic

Airbus A319, Boeing 737-800. No damage. No injuries.

A controller's loss of awareness of the airplanes' flight paths resulted in the issuance of a climb clearance that placed the A319 and the 737 on a head-on collision course off the eastern coast of the United States the evening of Nov. 11, 2010, according to an NTSB incident report.

The flight crews of both airplanes received, and followed, traffic-alert and collision avoidance system (TCAS) resolution advisories that resulted in the A319 and the 737 passing about 1,800 ft vertically and 2.8 nm (5.2 km) laterally of each other about 66 nm (122 km) east of Hobe Sound, Florida.

The A319 had been southeast-bound at Flight Level (FL) 360 (approximately 36,000 ft), en route from Washington to Bogotá, Colombia. The 737 was northwest-bound at FL 370, en route from Oranjestad, Aruba, to Atlanta.

The report said that the 737 was still "well within" Miami Air Route Traffic Control Center (ARTCC) Sector 21 when the sector controller handed off the flight to the controller of an adjacent sector, Sector 2, which the 737 eventually would enter — and which the A319 was transiting. About a minute later, the Sector 2 controller handed off the A319 to the Sector 21 controller.

The Sector 21 controller had the 737's data tag from his radar display and "did not maintain awareness" of the airplane's position after handing off the 737 to the Sector 2 controller, the report said. Unaware of the conflict he was creating, the Sector 21 controller cleared the A319 to climb to FL 370, "which placed the flight in direct conflict with the 737," the report said.

Shortly thereafter, the ARTCC's radar data processing system generated a conflict alert, and the sector controllers radioed traffic advisories and instructions to resolve the conflict. However, the flight crews of both airplanes replied that they were following TCAS resolution advisories. The 737 crew also reported that they had the A319 in sight.

Tug Slides on Slippery Ramp

Bombardier CRJ200. Substantial damage. No injuries.

The airplane had been dispatched with its auxiliary power unit (APU) inoperative per the minimum equipment list and was two hours behind schedule for departure from Salt Lake City the night of Nov. 23, 2010. "The captain stated that he started both engines [using an external power cart] due to a concern that by starting one engine only he would encounter control problems taxiing in the slippery conditions," said the NTSB report.

Snow was falling, and the ramp area was covered with snow and ice. "During pushback, the tug was unable to gain enough traction to move the airplane and was subsequently replaced with a larger tug," which initially was able to move the CRJ, the report said. However, the airplane, with both engines at idle power, began to overpower the tug.

"The captain … experienced a sensation of unusual movement [and] asked the tug driver if the driver still had control of the airplane," the report said. "The tug driver confirmed that he had control; however, the airplane subsequently moved forward while still attached to the tug, which rotated to the right, striking the airplane's fuselage." The collision damaged the CRJ's lower fuselage skin and several stringers.

The report said that a factor contributing to the accident was that "no guidance existed for either the flight or ground crew regarding pushback procedures in low-traction ramp conditions with an inoperative APU."

TURBOPROPS

Altitude Deviation Unnoticed

Bombardier DHC-8-100. No damage. No injuries.

Inadequate monitoring of flight instruments resulted in the continuation of a gradual descent that placed the Dash 8 on a head-on collision course with another aircraft off the east coast of the Hudson Bay the afternoon of Feb. 7, 2011, said a report by the Transportation Safety Board of Canada (TSB). The TSB also faulted the absence of simulator training on TCAS maneuvers for the initial incorrect reactions by the pilots of both aircraft to TCAS resolution advisories.

The aircraft, both Dash 8s operated by the same airline, were flying in opposite directions between Puvirnituq and La Grande-Rivière, Quebec, in VMC but in airspace not covered by air traffic control (ATC) radar. The DHC-8-100, with 28 passengers and three crewmembers, was northbound to Puvirnituq at FL 230; the other aircraft, a DHC-8-300, was southbound at FL 220 with three crewmembers.

The -100 crew was using the autopilot's vertical-speed mode to maintain altitude because of pitch oscillations that often occurred when the altitude-hold mode was selected. "The use of [vertical-speed] mode is neither intended for nor evaluated for this function, but nothing prohibited the flight crew from using it to maintain altitude," the report said.

The captain was alone in the cockpit, after the first officer left for "physiological reasons," and did not notice when the -100 began to descend at about 50 fpm, the report said. "Since the rate of descent was very slow, the speed and attitude of the aircraft were very similar to those of cruise flight. It was therefore impossible to note the descent without reference to the flight instruments."

During the next 14 minutes, the -100 descended about 700 ft. The captain apparently did not notice the altitude-warning light. The first officer was re-entering the cockpit when the TCAS generated a traffic advisory, then a resolution advisory to climb. The captain disengaged the autopilot and began a 38-degree-banked right turn. "During this turn, the aircraft lost just over 50 ft in altitude before beginning to climb," the report said, noting that the right turn might have been an automatic reaction to opposite-direction traffic.

Meanwhile, the pilot flying the -300, the first officer, had begun a shallow left climbing turn after misinterpreting the TCAS "descend" resolution advisory displayed on the vertical speed indicator. "It is possible that the appearance of the [-100 target symbol] in the upper right-hand corner of the display may have caused the [pilot] to turn left," the report said.

During these maneuvers, the aircraft passed within 1,500 ft vertically and 0.8 nm (1.5 km) laterally. Both aircraft then continued to their destinations without further incident.

Lesions Induce Disorientation

CASA 212-100. Destroyed. Five fatalities.

ATC radar and radio contact with the aircraft were lost about 26 minutes after it departed from Batam, Indonesia, with two pilots and three company engineers for a functional check flight the afternoon of Feb. 12, 2011. The wreckage was found on Bintan Island, and subsequent examination revealed that the propeller on the left engine was not rotating on impact, said the report by the Indonesian National Transportation Safety Committee.

Investigators found signs that the left engine had erroneously been placed in reverse before the pilots lost control of the aircraft. They found no check flight plan or authorization for the PIC to conduct the check flight following replacement of the left engine. The PIC, 61, had 13,027 flight hours, including 3,311 hours in type. The first officer, 50, had 2,577 flight hours, including 152 hours in type.

A postmortem examination of the PIC revealed lesions that had caused paralysis of the vestibular organs in his right inner ear. The report said this condition meant that the pilot "could not [respond] normally to three-dimensional motion or movement" and may have induced spatial disorientation.

Windshield Shatters

Beech C90 King Air. Minor damage. No injuries.

The airplane had departed from Champaign, Illinois, U.S., and was climbing through 23,400 ft the afternoon of Feb. 9, 2011, when the flight instructor and commercial pilot receiving instruction heard a loud bang as the inner ply of the copilot's windshield shattered.

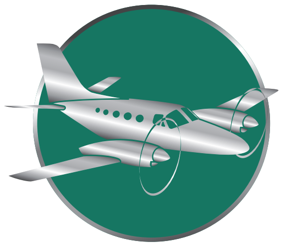
"The [instructor] noted that the flight was in clouds and that the temperature aloft … was minus 23 degrees C [minus 9 degrees F]," the NTSB report said. "Additionally, he stated that there was no visible structural icing present and the electric window heat was on."

The instructor declared an emergency and requested and received vectors from ATC to the nearest suitable airport, Evansville, Indiana, where the airplane was landed without further incident.

Examination of the windshield revealed a peel-chip fracture of the inner ply. This type of fracture "has historically been an issue on the King Air" and prompted the windshield

Examination of the windshield revealed a peel-chip fracture of the inner ply.

manufacturer in 2001 to incorporate a layer of urethane "that relieves stresses on the inner glass ply and prevents peel chip-type fractures," the report said. "This airplane did not have the improved windshield."



PISTON AIRPLANES

Task Overload Suspected

Beech B55 Baron. Substantial damage. Two serious injuries.

The landing gear warning horn sounded shortly after the airplane departed from San Luis Obispo, California, U.S., the morning of Feb. 7, 2011. "The pilot diagnosed the problem and determined that the landing gear had retracted successfully and that the indication system was in error," the NTSB report said. "He continued the flight with the horn intermittently sounding."

Nearing the destination — San Bernardino, California — the pilot received an unexpected clearance from ATC to navigate directly to the airport. "As a result, he rushed through the descent checklist items," the report said.

The pilot then requested and received clearance from ATC to make a low pass over the runway so that the airport traffic controllers could perform a visual check of the landing gear. During the low pass, the pilot began to have difficulty controlling the Baron and did not realize that the right engine had lost power due to fuel starvation, as confirmed by the airplane's on-board engine-monitoring system.

The pilot subsequently lost control of the airplane, which crashed in a nose-down, inverted attitude in a recreational vehicle storage facility.

Examination of the Baron revealed no airframe or engine anomalies that would have precluded normal operation. Investigators found that the pilot had not switched from the auxiliary fuel tanks to the main tanks during descent or approach, and that the right engine had lost power after the fuel in the right auxiliary tank was exhausted.

The report said that the unexpected approach clearance and the low pass over the runway might have caused the pilot to experience "task overload" that contributed to his improper fuel system management.

Descent Beneath Low Clouds

Cessna 340. Destroyed. Two fatalities.

The pilot was en route under visual flight rules from Henderson, Nevada, U.S., to Compton, California, the afternoon of Jan. 18, 2010. He held a private pilot certificate with a multiengine rating but did not have an instrument rating. His total flight time was 474 hours.

The airplane was cruising at 10,500 ft when it encountered instrument meteorological conditions, and the pilot initiated a descent. Recorded ATC radar data showed an "erratic and circling flight path" before radar contact was lost at 4,800 ft. "It is likely that the pilot was having difficulty determining his location and desired flight track," the NTSB report said.

A glider pilot, who was driving on a highway in the area, saw an airplane matching the description of the 340 flying at 200 ft AGL just below the clouds and in "bad" visibility. About eight minutes after the witness lost sight of the airplane, the 340 struck the slope of a gully at about 2,490 ft near Lytle Creek, California.

Engine Fails, Control Lost

Piper Twin Comanche. Substantial damage. One serious injury.

The airplane recently had undergone maintenance that included overhaul of both engines. The pilot had called the maintenance facility after landing in Big Bear City, California, U.S., on Jan. 29, 2011, to report that the right engine was running rough. "A mechanic was not available to help him, and he was told that he should not fly the airplane," the NTSB report said.

The pilot apparently had no further contact with the maintenance facility before attempting to depart from Big Bear City for a flight to Pacoima, California, the next morning. A witness heard the engines popping and backfiring before the airplane began the takeoff roll.

The pilot told investigators that he was turning onto a left crosswind when the right engine lost power. "He continued the left turn to downwind and made sure to keep the airspeed above the single-engine control speed of 90 mph," the report said. "The pilot's last recollection was turning to final approach and seeing the runway."

The report said that the pilot allowed airspeed to decrease below the single-engine control speed; information recovered from the Twin Comanche's global positioning system indicated that the groundspeed was 76 mph about 1,400 ft (427 m) from the runway threshold. "The airplane subsequently impacted the roof of a private residence located about 900 ft [274 m] from the runway threshold," the report said. "The airplane came to rest inverted in the front yard."

Examination of the wreckage revealed nothing to explain the loss of power, but the report said that a contributing factor in the accident was "the pilot's decision to fly with a known deficiency in one engine."

HELICOPTERS

Control Fastener Detaches

Robinson R44 Astro. Destroyed. Two fatalities, one serious injury.

As part of a biennial flight review at Cessnock Aerodrome in New South Wales, Australia, the morning of Feb. 4, 2011, the instructor simulated a failure of the flight control hydraulic boost system. After landing the helicopter, the pilot told the instructor that the hydraulic system would not re-engage.

The passenger, who normally flew the helicopter, told the instructor that the system had been leaking and that he had replenished the reservoir that morning. "The instructor announced that he would reposition the helicopter to the apron to facilitate examination of the hydraulic system," the ATSB report said.

The instructor lost control of the R44 shortly after becoming airborne. The helicopter was in a steep left bank when it struck the runway and came to rest on its left side. A fire erupted and rapidly engulfed the helicopter. The pilot was able to escape, but the instructor and the passenger succumbed to thermal injuries.

Investigators found that the bolt securing the lower flight control push-pull tube to the left-front hydraulic servo had detached while the helicopter was on the ground following the simulated hydraulic failure. "The 'feel' of the flight control fault [would have] mimicked a hydraulic system failure," the report said.

Although the precise cause of the bolt detachment was not determined, investigators found that "a number of self-locking nuts from other aircraft, of the same specification as that used to secure safety-critical fasteners in [the accident helicopter] were identified to have cracked due to hydrogen embrittlement."

The report noted that the aluminum fuel tanks in the helicopter had not been replaced with bladder tanks, as recommended by a service bulletin issued by the manufacturer in December 2010 to "improve the R44 fuel system's resistance to a post-accident fuel leak."

Control Lost After Tail Strike

McDonnell Douglas 369FF. Substantial damage. One fatality, two serious injuries, one minor injury.

The police helicopter was being used to scout a 3,600-ft mountaintop near Marana, Arizona, U.S., for installation of emergency communications equipment the morning of Jan. 31, 2011. The NTSB report said that the weather conditions, which included 10- to 15-kt winds, were "within the helicopter's and the pilot's performance capabilities."

The pilot circled the peak before attempting a pinnacle landing. "The passengers reported that during the landing attempt, they felt a bump, the helicopter rose a few feet, then the nose pitched down and the helicopter began to spin to the right," the report said. "The helicopter tumbled and slid about 120 ft [37 m] down a shallow canyon … before it was halted by rocks and scrub vegetation."

Investigators determined that the pilot, who was killed in the crash, had lost control of the helicopter after the tail rotor struck the ground during the attempted pinnacle landing.

Preliminary Reports, December 2012

Date	Location	Aircraft Type	Aircraft Damage	Injuries
Dec. 5	Drakensberg, South Africa	Aero Modifications C-47TP	destroyed	11 fatalities
The turbine-modified Douglas DC-3, operated by the South African air force, struck a mountain while being flown in severe weather conditions.				
Dec. 7	La Yesca, Mexico	Britten-Norman Islander	destroyed	NA
The Islander was departing for an air ambulance flight when it encountered a strong crosswind and drifted sideways into trees. All three occupants survived the crash.				
Dec. 9	Iturbide, Mexico	Learjet 25	destroyed	7 fatal
The Learjet was on a charter flight from Monterrey to Toluca when it entered a high-speed descent from 28,000 ft and struck mountainous terrain.				
Dec. 10	Compton, Illinois, U.S.	MBB BK-117A-3	substantial	3 fatal
The helicopter crashed during an emergency medical services positioning flight from Rockford to Mendota, Illinois.				
Dec. 12	Zulia, Colombia	Piper Seneca	destroyed	4 fatal
The Seneca was en route under visual flight rules when it struck rising terrain in instrument meteorological conditions.				
Dec. 14	Amarillo, Texas, U.S.	Beech King Air E90	destroyed	2 fatal
Shortly after departing from Amarillo and receiving clearance to deviate from course to avoid weather, the pilot lost control of the King Air, which then broke up in flight.				
Dec. 15	Ely, Nevada, U.S.	Piper Cheyenne	destroyed	2 fatal
The Cheyenne was cruising at 24,000 ft in visual meteorological conditions (VMC) when it entered a right turn and descended within 30 seconds to 14,500 ft, where radar contact was lost. The airplane broke up before crashing in a canyon.				
Dec. 17	Tomas, Peru	Antonov 26-100	destroyed	4 fatal
The An-26 crashed in the Andes during a cargo flight from Lima to Las Malvinas.				
Dec. 18	Payson, Arizona, U.S.	Piper Chieftain	substantial	1 fatal
The cargo airplane was nearing Payson when the pilot requested and received clearance to divert to Phoenix due to poor visibility at the destination. Shortly thereafter, the Chieftain struck a mountain at about 7,000 ft.				
Dec. 18	Libby, Montana, U.S.	Beech King Air B100	substantial	2 fatal
Night VMC prevailed at the airport when the King Air struck trees and crashed in mountainous terrain during a visual approach.				
Dec. 20	Holtanna Glacier, Antarctica	Basler BT-67	substantial	2 minor, 13 none
The air-tour airplane struck a snow drift while lifting off from an unprepared airstrip. The turbine-modified DC-3 then stalled and landed hard, collapsing the main gear.				
Dec. 21	Oklahoma City, Oklahoma, U.S.	Cessna 550 Citation	substantial	1 minor, 1 none
The Customs Service airplane overran the runway after the nose landing gear collapsed on touchdown.				
Dec. 22	Sanikiluaq, Nunavut, Canada	Swearingen Metro III	destroyed	1 fatal, 2 serious, 6 minor
The flight crew was attempting a second approach in adverse weather conditions when the Metro touched down hard and overran the runway.				
Dec. 24	Leesburg, Florida, U.S.	Piper Chieftain	NA	1 fatal
Witnesses said that the engines were not functioning properly when the Chieftain stalled and crashed on approach.				
Dec. 25	Shymkent, Kazakhstan	Antonov 72-100	destroyed	27 fatal
Visibility was about 800 m (1/2 mi) in heavy snow and the ceiling was at 400 ft at Shymkent when the An-72 crashed on approach, about 20 km (11 nm) from the airport.				
Dec. 25	Heho, Myanmar	Fokker 100	destroyed	2 fatal, 8 serious, 62 minor
One person on the ground was killed when the Fokker struck power lines on approach in fog and crashed about 1 km (0.5 nm) from the runway.				
Dec. 29	Moscow, Russia	Tupolev 204-100V	destroyed	5 fatal, 3 serious
The surface winds were from 280 degrees at 16 kt, gusting to 29 kt, when the Tu-204 overran Runway 19 on landing and struck a highway embankment during a positioning flight.				
Dec. 31	San Pedro Sula, Honduras	British Aerospace Jetstream 31	substantial	1 minor, 18 none
VMC with light winds prevailed when the Jetstream veered off the runway on landing and struck a ditch.				

NA = not available

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