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AeroSafety WORLD

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Updated Simulators

STUMBLES IN SAR
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UNRESTRAINED
Fatal Shift in Cargo Hold

BURNING CONFLICT
SMALL UAS VS. AERIAL FIREFIGHTERS

THE JOURNAL OF FLIGHT SAFETY FOUNDATION

JULY–AUGUST 2016

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SHARED Responsibility

Aviation safety is both an individual and a shared responsibility. The decisions and actions of individuals can have a profound impact on safety in specific situations, and aviation's justifiably admired safety record is the result of cooperative risk identification and mitigation efforts between industry and government and across organizations, industry sectors and borders.

Both points have been driven home in the 16 months since the Germanwings Flight 9525 crash in the French Alps killed 150 passengers and crew as a result of the "deliberate and planned action of the copilot, who decided to commit suicide while alone in the cockpit." As has been well documented, the accident investigation found that the copilot was taking prescription antidepressants with possible significant side effects and that, just weeks before the crash, a doctor had recommended treatment in a psychiatric hospital. But neither the pilot's employer nor the appropriate regulator were informed. The crash was a result of a decision made by an individual suffering mental health issues, and the system set up to mitigate such risks failed to do so.

Subsequently, a U.S. Federal Aviation Administration (FAA) Aviation Rulemaking Committee (ARC) comprising aviation and medical experts made several recommendations regarding pilot mental fitness. Peter Stein, a professional pilot and attorney who sits on the Foundation's Board of Governors, represented the Foundation on the ARC. FAA, airlines and pilots' unions considered the ARC's recommendations and agreed to several actions, including airlines and unions expanding the use of pilot assistance programs and incorporating them into airline safety management systems; FAA working with airlines to develop programs to reduce the stigma around mental health issues; FAA issuing guidance to airlines to promote best practices about pilot support programs for mental health issues; and FAA asking the Aerospace Medical Association to consider addressing the issue of professional reporting responsibilities on a national basis and to present a solution to the American Medical Association. Reporting requirements currently vary by state and by licensing and specialty boards.

As is the case with issues of physical health, the industry needs to work together to encourage pilots to report when they are unfit for duty and to seek professional help for mental health issues. Working to reduce the stigmas that surround mental health issues will be key to this effort. We as an industry cannot allow pilots with serious mental health issues to have access to the flight deck. All states need to examine their privacy laws with affirmative reporting obligations for individuals with known health conditions that can put the safety of the travelling public at risk.

Jon L. Beatty
President and CEO
Flight Safety Foundation

AeroSafety WORLD

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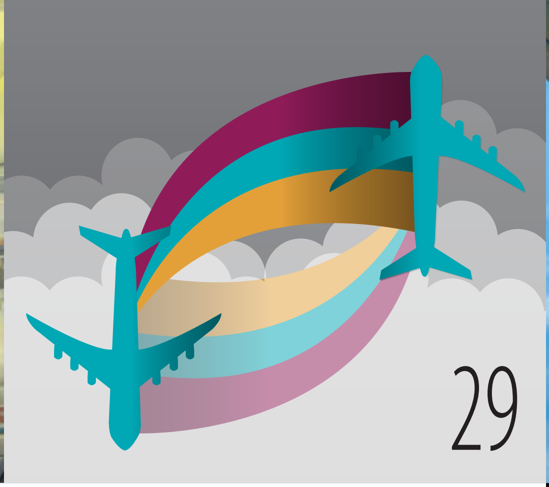

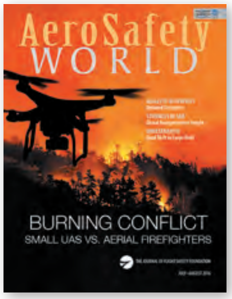

About the Cover
Intrusive small UAS aircraft have repeatedly forced suspension of aerial firefighting operations.
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If you have an article proposal, manuscript or technical paper that you believe would make a useful contribution to the ongoing dialogue about aviation safety, we will be glad to consider it. Send it to Editor-In-Chief Frank Jackman, 701 N. Fairfax St., Suite 250, Alexandria, VA 22314-2058 USA or jackman@flightsafety.org.

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November 14–16
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IASS 2016

69th annual International Air Safety Summit

UAS in Your Skies

Understanding the safe integration of Unmanned Aircraft Systems (UAS) is presently a matter of great interest to the aviation industry, government regulators, and the general public. Attend **IASS 2016** to gain insight into safety challenges and current technology during a dedicated session on UAS.

Safety UAS Integration Challenges: Views and Concerns from the Airline Cockpit

Anthony 'Jim' Pala, UAS Member and William 'Chris' Lucius, UAS Project Lead, Aircraft Operations & Design Group, ALPA

How Much Safety do Small Drones Embed?

Dr. Nektarios Karanikas, Associate Professor of Safety & Human Factors, Aviation Academy of the University of Amsterdam Applied Sciences

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flightsafety.org/meeting/iass-2016

Focus on M&E

Airbus forecast in July that $1.8 trillion will be spent on commercial aviation maintenance, repair and overhaul (MRO) activities over the next 20 years as part of a projected $3 trillion spend on global aftermarket services. In its first Global Services Forecast, which was released at the Farnborough Air Show, the airframe manufacturer said that on an annual basis, MRO spending will grow from $53 billion to $132 billion over the forecast period, which works out to average annual growth of 4.6 percent.

MRO is a big and potentially lucrative business. It's also a complex endeavor that takes training, skill and coordination to accomplish effectively. And, most importantly, it is critical to the safety of flight.

Many of the same issues we discuss regularly in terms of flight operations also apply to the maintenance and engineering realm. Fatigue risk management, fitness for duty, communications, crew resource management, safety culture and effective oversight, to name a few, all play important roles in MRO.

I think the MRO world is fascinating. I spent a number of years in a previous job editing a magazine that focused on the commercial, military and business aviation aftermarkets. I also think that many aviation safety conferences and seminars focus largely on flight operations, and the organizers of most — but not all — maintenance events are content to deal with commercial issues and seldom stray further than the occasional human factors discussion when it comes safety.

So, I'm extremely excited that at our 69th annual International Air Safety Summit (IASS) in mid-November in Dubai, United Arab Emirates, we will be offering a one-day maintenance and engineering (M&E) track that will run concurrently with the regular schedule on day two of our three-day IASS. Foundation Vice President, Global Programs, Greg Marshall and the FSF International Advisory Committee have developed an agenda that will feature presentations on practical risk management, maintenance human factors, safety culture as a contributor to operator safety, maintenance line operations safety audits, and fatigue risk management for maintenance organizations.

This won't be the first time we've run an M&E-focused event — we've done maintenance events the last two years in Singapore as part of our Singapore Aviation Safety Seminars series, but this will be the first time in recent memory that we've done a concurrent track at IASS. I think you will find the content useful and actionable. For more information on IASS 2016, please visit our website at <flightsafety.org/meeting/iass-2016>.

Frank Jackman
Editor-in-Chief, ASW
Flight Safety Foundation

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

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JULY 25-26 ➤ Aircraft Interior Design, Engineering and Safety Course. Association of Aerospace Industries (Singapore). Singapore. <aais.org.sg/training>.

JULY 26–27 ➤ Pro Auditor Training Course. Mentair Group. Omaha, Nebraska, U.S. <mentair.com>.

JULY 28 ➤ Flight Safety Foundation Annual Networking Dinner. Flight Safety Foundation. Washington. Namratha Apparao, <apparao@flightsafety.org>. +1 703.739.6700, ext. 101.

AUGUST 1–5 ➤ 53rd Conference of Directors General of Civil Aviation Asia and Pacific Region. Civil Aviation Authority of Sri Lanka. Colombo, Sri Lanka. <dgca53.lk>.

AUGUST 15–19 ➤ Electronic Systems Investigation. Southern California Safety Institute. Long Beach, California, U.S. <denise.davalloo@scsi-inc.com>. <scsi-inc.com/registration.php>.

AUGUST 22–25 ➤ 62nd Air Safety Forum. Air Line Pilots Association, International (ALPA). Washington. <safetyforum.alpa.org>.

SEPTEMBER 7–8 ➤ Asia Pacific Aviation Safety Seminar. Association of Asia Pacific Airlines (AAPA). Tokyo. <aapairlines.org/Asia_Pacific_Aviation_Safety_Seminar.aspx>.

SEPTEMBER 12 ➤ Advancing Business Aviation in Southern California. Southern California Aviation Association. Carlsbad, California. <socalaviation.org>.

SEPTEMBER 19–20 ➤ Barrier-Based Risk Management Network Event. CGE Risk Management Solutions. Amsterdam. <cgerisk.com/networkevent2016>.

SEPTEMBER 25 ➤ AACO 77th Executive Committee Meeting. Arab Air Carriers' Organization (AACO). Dubai, United Arab Emirates. <aaco.org>.

SEPTEMBER 26 ➤ ICAO World Aviation Forum. International Civil Aviation Organization. Montreal. <icao.int>.

SEPTEMBER 26–28 ➤ Air Medical Transport Conference. The Association of Air Medical Services. Charlotte, North Carolina, U.S. <aams.org/events/amtc/>.

SEPTEMBER 27–OCTOBER 7 ➤ ICAO 39th Triennial Assembly. International Civil Aviation Organization. Montreal. <icao.int/Meetings/a39/Pages/default.aspx>.

OCTOBER 5–7 ➤ BowTie Barrier-Based Training. TAG Bologna. Bologna, Italy. <sms@mys.it>. <mycs.it/bologna.htm>.

OCTOBER 11–13 ➤ Helitech International Helicopter Expo and Conference. European Helicopter Association. Amsterdam. <helitechevents.com>.

OCTOBER 11–13 ➤ ERA General Assembly. European Regions Airline Association. Madrid. <eraa.org/events/era-general-assembly-2016>.

OCTOBER 12–13 ➤ Air Ops Europe. European Business Aviation Association. Cannes, France. <airopseurope.aero>.

OCTOBER 17–20 ➤ ISASI 2016. International Society of Air Safety Investigators. Reykjavik, Iceland. <esasi.eu/isasi-2016>.

OCTOBER 24–27 ➤ Eighth Triennial International Aircraft Fire and Cabin Safety Research Conference. U.S. Cabin Safety Research Technical Group. Atlantic City, New Jersey, U.S. <fire.tc.faa.gov>.

OCTOBER 31–NOVEMBER 2 ➤ SAFE Association 54th Annual Symposium. Dayton, Ohio, U.S. SAFE Association. <safe@peak.org>. <safeassociation.org>.

NOVEMBER 1–3 ➤ NBAA's Business Aviation Convention and Exhibition (NBAA-BACE). National Business Aviation Association. Orlando, Florida, U.S. <nbaa.org/events/bace/2016/>.

NOVEMBER 3–4 ➤ International Cross-Industry Safety Conference. Aviation Academy of the Amsterdam University of Applied Sciences. Amsterdam. <amsterdamuas.com/aviation/events>.

NOVEMBER 6–11 ➤ CANSO Global ATM Safety Conference 2016. Civil Air Navigation Service Organisation. Budapest, Hungary. <canso.org/canso-global-atm-safety-conference-2016>.

NOVEMBER 14–16 ➤ 69th annual International Air Safety Summit (IASS 2016). Flight Safety Foundation. Dubai, United Arab Emirates. Namratha Apparao, <apparao@flightsafety.org>, +1 703.739.6700, ext. 101.

NOVEMBER 24–25 ➤ 5th annual Safety in African Aviation (SiAA) Conference. AviAssist. Livingston, Zambia. <2gether4safety.org>.

NOVEMBER 28–30 ➤ AACO 49th Annual General Meeting. Arab Air Carriers Organization. Casablanca, Morocco. <aaco.org/events/aaco/aaco-49th-agm>.

MARCH 6–9 ➤ HAI Heli-Expo. Helicopter Association International (HAI). Dallas, Texas, U.S. <heliexpo.rotor.org>.

MARCH 28-30 ➤ Singapore Aviation Safety Seminar (SASS) 2017. Flight Safety Foundation and Singapore Aviation Academy. Singapore. Namratha Apparao, <apparao@flightsafety.org>, +1 703.739.6700, ext. 101.

MAY 4-5 ➤ 62nd annual Business Aviation Safety Summit (BASS) 2017. Flight Safety Foundation in partnership with the National Business Aviation Association. Phoenix, Arizona, U.S. Namratha Apparao, <apparao@flightsafety.org>, +1 703.739.6700, ext. 101.

JUNE 6-7 ➤ 2017 Safety Forum. Flight Safety Foundation, Eurocontrol and European Regions Airline Association. Brussels, Belgium. <skybrary.aero>.

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If you have a safety-related conference, seminar or meeting, we'll list it. Get the information to us early. Send listings to Frank Jackman at Flight Safety Foundation, 701 N. Fairfax St., Suite 250, Alexandria, VA 22314-2058 USA, or <jackman@flightsafety.org>.

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

Safety News

Ice-Protection Alerting

The U.S. National Transportation Safety Board (NTSB), citing a fatal 2014 crash that it attributed largely to structural icing, is calling for development of a system to automatically alert pilots when ice-protection systems should be activated on certain turbofan airplanes.

In a safety recommendation letter to the U.S. Federal Aviation Administration (FAA), the NTSB said that the agency should work with the General Aviation Manufacturers Association (GAMA) to develop the alerting system for use in turbofan airplanes that require a type rating and that are certified for single-pilot operations and flight in icing conditions.


Josh Beasley | Wikimedia CC BY 2.0

The NTSB sent similar recommendations to GAMA and to the National Business Aviation Association.

The recommendations cited a Dec. 8, 2014, accident in which an Embraer EMB-500 (Phenom 100) crashed on approach to Montgomery County Airpark in Gaithersburg, Maryland, U.S. The airplane struck three houses about 0.75 nm (1.4 km) from the runway, killing all three people in the airplane as well as three people in one of the houses.

The NTSB said the probable cause of the accident was "the pilot's conduct of an approach in structural icing conditions without turning on the airplane's wing and horizontal stabilizer deice system, leading to ice accumulation on those surfaces, and without using the appropriate landing performance speeds for the weather conditions and airplane weight, as indicated in the airplane's standard operating procedures, which together resulted in an aerodynamic stall at an altitude at which a recovery was not possible."

Performance, Reviewed

The number of controlled flights by European air transport aircraft, total flight distance and total flight hours all increased in 2015, with increases in average annual growth expected to continue over at least the next seven years, according to the annual *Performance Review Report*.

The report — issued in June by the independent Performance Review Commission (PRC), which was established in 1997 by the Permanent Commission of Eurocontrol — said that the highest rates of annual growth in 2015 were recorded by Turkey, Bulgaria, Hungary, the United Kingdom and Spain.

An average annual growth rate of 2.2 percent is expected through 2022, the report said.

In many central European states, including Bulgaria and Hungary, the increased traffic was attributed to the rerouting of flights to avoid Ukrainian airspace, the report said. Malaysia Airlines Flight 17, a Boeing 777-200ER bound for Kuala Lumpur, Malaysia, from Amsterdam, was shot down over Ukrainian airspace on July 17, 2014, killing all 298 passengers and crew.

The report noted that Europe has not yet developed a definition and guidance for "acceptable levels of safety performance" — actions recommended by the International Civil Aviation Organization (ICAO). Although there is an "urgent need to provide this type of support and guidance," the report said, "it is still not clear how this concept will be introduced within the regulatory environment."

A common approach to the measurement and management of safety performance "would ensure a harmonized

© Eurocontrol

implementation of state safety programmes … and facilitate the exchange of safety information in the future," the report said.

The document also noted ongoing changes in the safety-reporting environment and said that a "transition phase" is likely over the next few years.

"During this time, in order to maintain and improve European reporting, it is important that actors responsible for the collection of safety data work together in order to create an optimum solution," the report said. "Nevertheless, the PRC has to express its concern that during this transition phase, availability, completeness and quality of safety data may deteriorate due to the lack of arrangements between all parties involved in the process."

Updated EU Blacklist

The European Commission (EC) has updated its Air Safety List — its so-called blacklist — of airlines banned from operating within the European Union (EU) because they do not meet international safety standards.

The revised list, issued in mid-June, names 216 airlines, including 214 that are based in 19 countries "due to a lack of safety oversight by the aviation authorities" and two individual airlines "based on safety concerns," the EC said. In addition, six airlines are prohibited from operating except under specific conditions, including requirements that they use specific aircraft types.

The update removed from the blacklist all airlines certified in Zambia, along with three airlines certified in Indonesia and one in Madagascar; most aircraft flown by Iran Air also were permitted to resume EU operations.

The updated list was developed "based on the unanimous opinion of the safety experts from the member states" during a meeting in early June, the EC said.

The full list of banned airlines is available at <ec.europa.eu/transport/modes/air/safety/air-ban/index_en.htm>.

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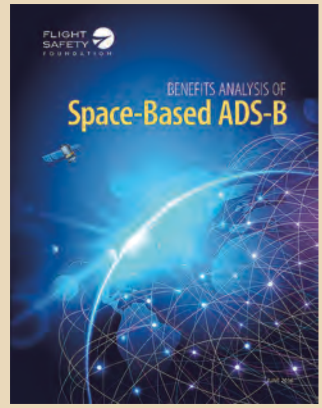
Benefits of Space-Based ADS-B

Space-based automatic dependent surveillance–broadcast (ADS-B) networks will not only boost aircraft surveillance but also enable reduced oceanic separation, according to a study conducted for Flight Safety Foundation.

The study was designed to assess the ability of space-based ADS-B networks to meet anticipated safety challenges of air traffic growth over the next 20 years by introducing near-real-time flight surveillance capability with 100 percent global coverage.

"The integrity and accuracy of space-based ADS-B should introduce significant safety benefits to avoid positional errors for aircraft within adjacent flight information regions (FIRs)," the Foundation said. "In addition, handover between air traffic controllers at FIR boundaries should be more precise due to near-real-time situational awareness," which will reduce the workload for both air traffic controllers and pilots.

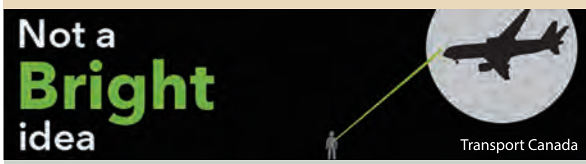
Greg Marshall, Foundation vice president for global programs, added that "the many benefits of terrestrial-based ADS-B are now very well known, with many countries already having adopted the technology to the benefit of air carriers and air navigation service providers alike. Space-based ADS-B is one technology that promises to extend those benefits to airspace currently not covered by conventional surveillance technology."



Flight trajectory monitoring currently is limited to about every 30 minutes in oceanic and remote airspace, but space-based ADS-B would provide data updates about once every eight seconds, the Foundation said.

Another benefit of space-based ADS-B would be its ability to provide time-critical flight data to assist in aircraft accident investigations, the Foundation said, noting that past accidents have shown that "locating black boxes can prove challenging to rescue teams and air accident investigators due to extensive search areas and inhospitable environments."

The study also reviewed areas that are likely to present challenges to ADS-B use, including the need for some air navigation service providers to upgrade their air traffic control systems, as well as for avionics equipage mandates to be met.



Transport Canada

Anti-Laser Campaign

The Canadian government has stepped up its efforts to inform Canadians of "the dangers and consequences of pointing a laser at aircraft."

Pointing a laser beam at an aircraft can "distract pilots, cause glare that affects their vision, or worse, temporarily blind them," Transport Canada (TC) said in launching its campaign in June.

Transport Minister Marc Garneau added, "Pointing a laser at an aircraft is not only a reckless act that puts people at unnecessary risk, it's simply not a bright idea. … Canadians and their families deserve to feel safe while flying. We want people to know there are serious consequences, including $100,000 in fines and up to five years in prison."

TC asked the public to report laser strikes on aircraft to local police or to a TC regional office.

Nearly 600 laser strike incidents were reported to TC in 2015, compared with 502 that were reported the previous year, TC said.

Data Exchange

Eurocontrol and the General Civil Aviation Authority (GCAA) of the UAE have implemented real-time flight data exchange, Eurocontrol representatives say.

The data exchange was implemented in early June as part of the Collaborative Global Air Traffic Flow Management Concept, which Eurocontrol described as supporting the seamless management of major air traffic flows required under the International Civil Aviation Organization's Global Air Navigation plan.

"Real-time updates of departure times and other trajectory information is now being exchanged between the operational systems of Eurocontrol Network Manager and the UAE main air traffic control centre on the major traffic flows between Europe and the UAE," said Eurocontrol Director General Frank Brenner.

About 400 flights are conducted each day between the two regions, as well as an additional 150 to 200 overflights, Eurocontrol said, noting that traffic is increasing 3.6 percent a year.

Joe Sultana, director of the Network Manager Directorate at Eurocontrol, said that full implementation of the agreement will aid air traffic management (ATM) by providing more accurate flight information and improving the predictability of traffic flow.

"ATM predictability is a major enabler of capacity, and the 64 air traffic control centers in Europe and the European airports will directly benefit from the receipt of … updated trajectory information."

NOAA

Safeguarding Walrus 'Haul-Outs'

Pilots are being warned against low flights over the Alaska Peninsula that might alarm walruses, causing them to stampede, endangering both their young and humans on the ground.

The U.S. Federal Aviation Administration (FAA) said in June that it was collaborating with the U.S. Fish and Wildlife Service to educate pilots about the locations of walrus "haul-outs" — areas of sea ice where walruses rest after foraging for food on the ocean floor. Changes in sea ice have prompted walruses to haul out on land, prompting concerns about their reaction to low-flying aircraft, the FAA said.

In Other News …

No immediate changes in **U.K. civil aviation regulations** are expected as a result of the June decision by U.K. voters to leave the European Union (EU), the U.K. Civil Aviation Agency (CAA) says. Future changes "will depend on the outcome of the U.K.'s negotiations on exiting the EU," the CAA said. … The U.S. Federal Aviation Administration (FAA) has not provided sufficient oversight of **aircraft rescue and fire fighting** (ARFF) services at U.S. airports, according to an audit by the Department of Transportation's Office of Inspector General. The audit says that FAA inspectors have not consistently reviewed airports' compliance with ARFF regulations and policy and have "not sufficiently investigated potentially serious violations of ARFF requirements or reported enforcement data to [their] own database."

Compiled and edited by Linda Werfelman.

Australian Government
Department of Defence

International Military Airworthiness Regulation Conference

14-15 November 2016.
Melbourne, Australia.

Hosted by the Australian Director General Technical Airworthiness, this two day conference provides Airworthiness Authorities and Industry partners with a forum to gain insight into:

- the benefits of an emerging global convention on military airworthiness regulation,
- lessons learned from organisations that have transitioned to a new airworthiness system.

For information and to register go to
www.defence.gov.au/DASP/IMARC

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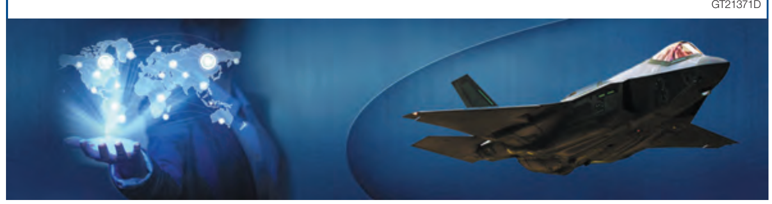


BARS and

Earlier this year, Flight Safety Foundation's Basic Aviation Risk Standard (BARS) Program Office in Melbourne, Australia, announced that the state government of Victoria's Department of Environment, Land, Water and Planning (DELWP) had become a Tier 1 BARS Member Organization. Subsequently, Lisa Frye, manager of the DELWP Aviation Services Unit, which is responsible for planning, procuring and developing aviation capability for fire and emergency management in Victoria, talked with *AeroSafety World* about the benefits of BARS. Her following comments have been edited for length and clarity:

How vital is BARS for improving aviation safety standards for service organizations in Australia and around the world?

Having a documented aviation risk standard means that when we say something about safety, we all know what that looks like, and everyone is on the same page. This is important to us because we don't own or fly the aircraft. We contract the services from professional aircraft operators, and we need to know that they have effective safety management systems in place. BARS is a consistent, independent and international standard.

It's a great tool for linking back to business priorities, too. For example, we can show how investment in particular aviation projects (like training) can reduce our risk profile and improve safety.

You have been advocating for BARS to be a compulsory standard. What is the impetus behind the push?

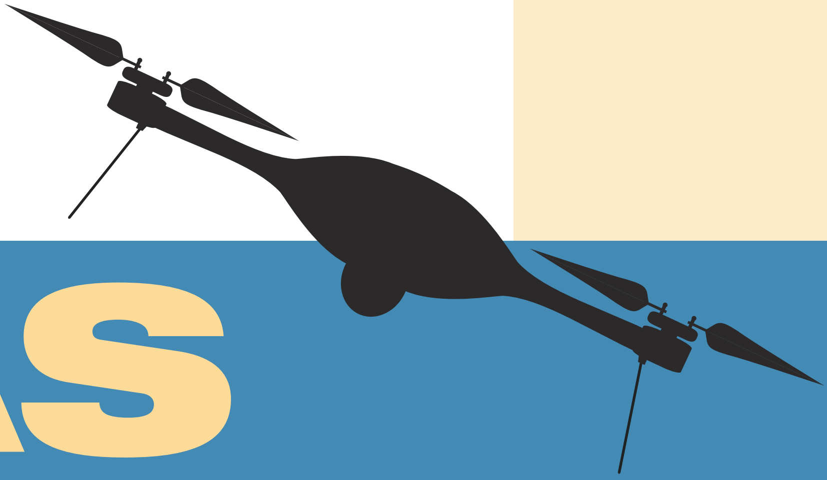
Although we are fire and emergency services, we are also part of the broader aviation sector, so we can learn from aviation safety and incidents in other industries as well as our own. In that respect, BARS is like a one-stop shop, representing the collective wisdom of the aviation industry. The next step would be to have a BARS-equivalent tailored to the needs of our fire aviation sector, like the resource sector does.

I like BARS because it is clear, transparent and easy to understand across all areas of our business. Most importantly, it doesn't just highlight the risks or threats; it also tells us what to do about them, what controls are needed in order to mitigate particular risks. The audit checklists then ensure that those risks are mitigated.

Has your support for the program been reciprocated by industry or has there been resistance?

I don't think there is resistance to the program in general; in fact, several of our aircraft operators are already BARS members and have regular audits.

DELWP signed up to the program so that we could manage risks for our remotely piloted aerial systems (RPAS) trial. The working group for the project has been very supportive because



RPAS

we're not leaving safety to chance. Even though this is an innovation project, we are proactive in managing safety. There is a standard, and we're following it. Resistance might come from aircraft operators who are unclear about what they can get out of the standard.

For example, they might see safety as time consuming or a barrier to operations. I think this is a mistake. Safety standards are an enabler to efficient operations.

You have a Ph.D. in human factors; as a specialist in this field, how can support for BARS be increased?

People need to see the value in the program. They need to see that it is successful and that it will be an asset to their business. I think affordability of the program might also be an issue for some smaller aircraft operators.

When an AO [aircraft operator] shows us that they have done a BARS (or similar) independent safety audit, it immediately makes our decisions easier. We can see evidence about their systems and processes, and we don't have to guess. If they keep their BARS certification current, you can see a track record of safety management and improvement, and it gives you confidence in their operation, which counts for something.

In 2015, firefighters in Western Australia used a Lockheed Martin Procerus Technologies Indago UAS (unmanned aircraft system, also known as RPAS, unmanned aerial vehicles [UAVs] or drones) quadcopter to fly over a live fire and provide real-time intelligence to the Fire and Emergency Services Planning and Incident Management team. The Indago was able to provide information on the location of the fire edge, the intensity and location of hotspots, as well as identify through smoke the people and assets at risk. The Indago also assessed damage and transmitted real-time images of activities occurring on the ground. Australia's Civil Aviation Safety Authority (CASA) has formed its own position on this use of UAS in the past. What place do UAVs have in aviation and emergency services?

We are still exploring the use of UAVs or RPAS and how they might work for different operations, including fire and emergency. As with any other industry, the issues are about safety, deconfliction and airspace management.

Currently, DELWP is trialling different types of UAV platforms and sensors for our land management operations. For example, we're looking at coastal surveillance, dam inundation mapping, inspection of road infrastructure and wildlife surveys. We're using rotary-wing and fixed-wing UAVs to see which platforms work best for different tasks.

We're also trialling a Lockheed Martin extended endurance UAS for surveillance of planned burns. We are looking at doing overnight surveillance and longer-range missions at higher altitudes so that we survey large areas of landscape, using thermal imagery to monitor hotspots and assist with pre-burn and post-burn assessment. Taking imagery before a burn enables us to assess assets and different types of land tenure, while the after photos show how effective the burn was. We're trialling this at the moment to see if it adds value to the planned burning process.

UAV operators will need to develop a safety culture, like the rest of the aviation industry. I think BARS will help with that.

Is using UAVs to drop incendiary devices in global positioning system–marked positions for back-burning a safer and more accurate way of controlling fires by removing fuel in the path of the fire front?

It's an exciting area to think about, but we still have a long way to go before we could safely do anything like that. It's also important to ask what type of problem we're trying to solve with the technology, and also what makes the most business sense.

DELWP is watching the use of UAVs overseas, such as the recent trials with the Lockheed Martin K-Max helicopter for firefighting trials in the United States.

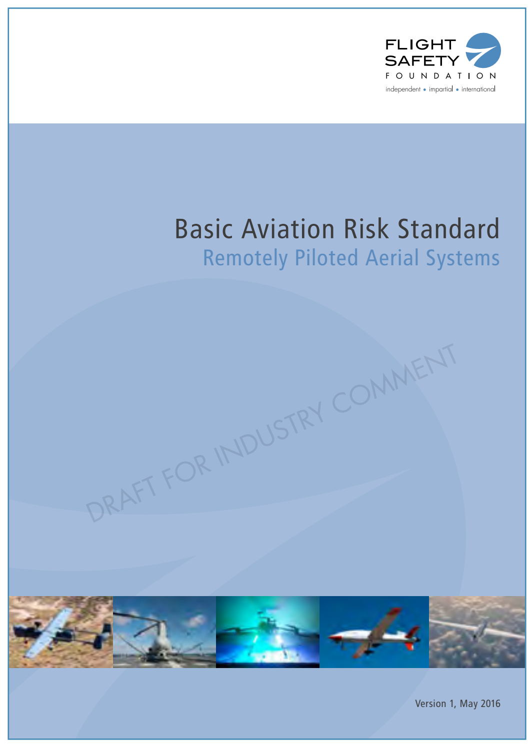
What is the viability of flying an intelligence-collecting UAV at an altitude higher than other firefighting aircraft (helicopters, air tankers, etc.)? As long as it remained in the temporary flight restriction area, interference with piloted aircraft would be minimized, but are there other concerns?

This sort of thing is already being done by the military. Some of the challenges for us are about how to manage safety in a more civilian setting. Again, the issues are about deconfliction, operating procedures and training.

The U.S. Federal Aviation Administration (FAA) and the U.S. Department of the Interior (DOI) have signed a memorandum of understanding (MoU) allowing the use of small UAS in Class G airspace (flying below 400 ft) to monitor natural resources and to conduct search and rescue missions. DOI is only the third agency to be granted this status, which enables staff to submit a certificate of waiver or authorization to the FAA to file flight plans and fly immediately without waiting for the FAA's approval. Do you feel Australia should introduce a similar MoU?

I can't speak for CASA about what it may or may not be doing. However, we have been working with CASA for our UAV trials, exploring what it takes to fly above 400 ft and beyond visual line of sight. The area approvals do take a long time, and this limits how the UAV capability can be used operationally. I think this will improve as we all get used to the technology, and the regulatory processes become more efficient.

Although drones have been around for more than 50 years in the military, it is still relatively early days when it comes to civilian and commercial applications. I think that at some point, general aviation traffic will have to learn how to share the airways and that might not be popular with pilots. At the same time, UAV operators will need to develop a safety culture, like the rest of the aviation industry. I think BARS will help with that.



A copy of the ***Basic Aviation Risk Standard for Remotely Piloted Aerial Systems (RPAS)*** is now available for industry comment on the FSF website under The BAR Standard <flightsafety.org/bars/bar-standard>.

BY RÉGINE HAMELIJNCK AND AMER YOUNOSSI

Safety Management Harmonization

Safety management systems (SMS) can be misunderstood, and the more civil aviation authorities can harmonize SMS requirements, the better for global aviation safety and industry organizations — in particular, for those that have multiple regulators. This principle led to the establishment of the Safety Management International Collaboration Group (SM ICG).

SM ICG was formed by the U.S. Federal Aviation Administration, the European Aviation Safety Agency, Transport Canada Civil Aviation and the International Civil Aviation Organization (ICAO) in 2009, when the aviation industry became concerned about the potential problems of meeting multiple sets of SMS requirements in order to operate in different countries. The industry asked regulators to harmonize the requirements.

The SM ICG now includes the initiating members and 15 additional aviation regulatory bodies that collaborate to promote a common understanding of safety management principles and requirements, facilitating their application across the international aviation community. Since its formation, the group has published 20 information products for safety management standardization and promotion; these products are distributed to the greater aviation community via SKYbrary, an electronic repository of aviation safety information. The group has also held eight successful Industry Day outreach events and will continue such interactions.

ICAO requires SMS for the management of safety risks in air operations, maintenance, air traffic services and airports. These requirements have been expanded to include flight training and the design and production of aircraft. ICAO has also published safety management requirements for states by mandating that they establish a state safety program (SSP) to achieve acceptable safety performance in their civil aviation systems. As such, it is beneficial for civil aviation authorities to harmonize their SMS and SSP requirements and implementation activities, and to collaborate on common topics of interest.

To that end, the SM ICG establishes short-term project teams to develop specific products for the wider aviation community. Product development focuses on creating a common understanding of safety management requirements; promoting alignment of safety management terminology; and providing implementation support, both for states (SSP) and aviation service providers (SMS), in the form of guidance material, tools, promotional material and training program guidance. The most recent SM ICG publications include *SMS for Small Organizations; SMS for Small Organizations: Considerations for Regulators; SMS Integration – Points to Consider;* and *Determining the Value of SMS.*

The SM ICG currently has three project teams developing guidance on comprehensive safety performance management, including determining the acceptable level of safety performance; a safety culture evaluation tool and guidance; and alignment of the SSP assessment tool with ICAO Annex 19, *Safety Management*, Amendment 1. After these publications are available, SM ICG members will promote their existence and inform industry organizations, ICAO and regulators that they can be downloaded from SKYbrary and tailored in ways that will work best for each user organization. Additionally, the SM ICG seeks feedback from the aviation community on the products it produces. Further information about the group, its membership and its products, is available at the SM ICG's SKYbrary website home page at <skybrary.aero/index.php/Portal:Safety_Management_International_Collaboration_Group_(SM_ICG)>.

Régine Hamelijnck is SMS coordination officer within the Flight Standards Policy and Planning Department of the European Aviation Safety Agency (EASA) and represents EASA in the SM ICG. Amer Younossi is deputy division manager for safety management and research planning for the U.S. Federal Aviation Administration Aviation Safety Organization. He initiated the SM ICG.

Fire Traffic Control

Government and industry safety specialists within commercial air transport and business aviation have confronted a number of situations in recent years in which pilots reported low-altitude traffic conflicts with small unmanned aircraft systems (UAS). Among concerns have been sightings of UAS aircraft — unknown to air traffic controllers — operating higher than 400 ft above ground level (AGL), evasive maneuvers and near-midair collisions near airports (see “Opening the Skies,” p. 21).

These specialists’ counterparts in the U.S. wildlands[1] aviation firefighting community have welcomed opportunities to share parallel experiences and the defensive measures they have taken so far, as discussed in their reports, a public education campaign and an update briefing with *AeroSafety World.*

They are applying risk-analysis methods, tools and tactics through their safety management systems to discourage intrusions by UAS operators that repeatedly have forced suspension of aerial firefighting operations in the fire traffic control areas (FTCAs) of wildfires. Research by subject matter experts shows that wildfires larger than 50,000 acres (20,234 hectares) have increased since 1986, with the largest increase in quantity of wildfires occurring since 2003 and many recent large wildfires ranked as more intense than those in historical records.[2]

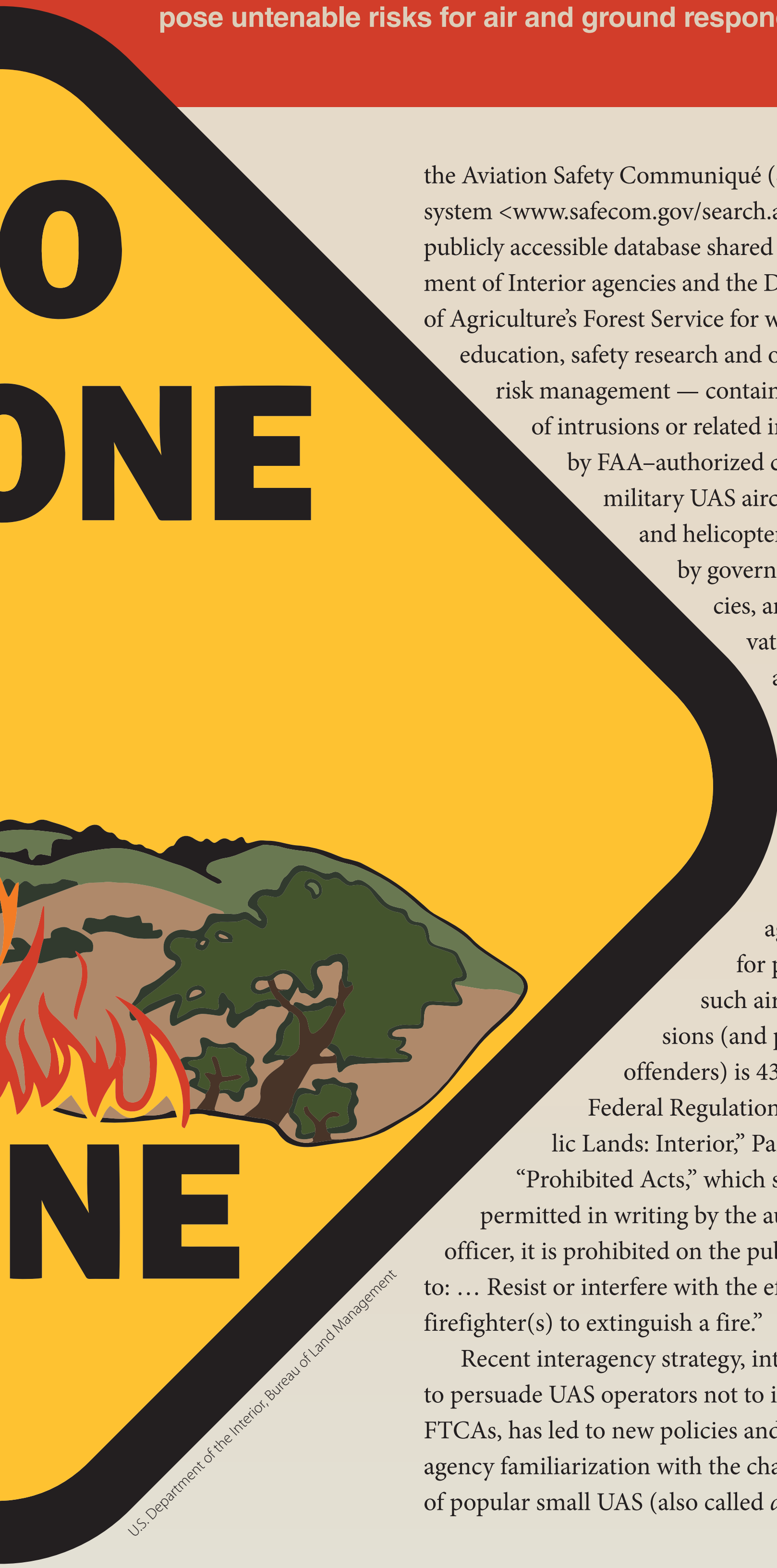
In this context, an *Interagency Aviation Safety Alert* to the wildlands aviation fire community in July 2014 said, “Increased unmanned aircraft activity presents hazards to *all* [wildlands fire] aviation users, including resource operations. Most commonly (but not exclusively), unmanned aircraft will be operating within close proximity to terrain, thus increasing risk for low-level resource operations. Resource operations including reconnaissance and aerial application with extremely limited reaction time usually operate without the protection a [U.S. Federal Aviation Administration (FAA) temporary flight restriction (TFR)] provides within most incident operations.”

National protocols[3] direct air and ground wildland firefighters’ response to UAS intrusions, derived from a fundamental policy that states, “The protection of human life is the single overriding suppression priority. Setting priorities among protecting public communities and community infrastructure, other property and improvements, and natural and cultural resources will be done based on the values to be protected, public health and safety, and the costs of protection. Once people have been committed to an incident, these human resources become the highest value to be protected.”

Three shutdowns of aerial firefighters’ responses to major California wildfires in June and July 2015 — now believed to have involved five privately flown UAS aircraft — received extensive news media coverage, but such incidents are not entirely unprecedented. For example,

BY WAYNE ROSENKRANS

Unauthorized UAS flights near U.S. wildfires — about 33 in 18 months — pose untenable risks for air and ground responders.



U.S. Department of the Interior, Bureau of Land Management

the Aviation Safety Communiqué (SAFECOM) system <www.safecom.gov/search.asp> — a publicly accessible database shared by Department of Interior agencies and the Department of Agriculture's Forest Service for wildfire safety education, safety research and operational risk management — contains reports of intrusions or related incidents by FAA–authorized civilian and military UAS aircraft, airplanes and helicopters operated by government agencies, and privately operated airplanes and helicopters.

Regardless of aircraft category, land management agencies' basis for prohibiting such aircraft intrusions (and prosecuting offenders) is 43 Code of Federal Regulations, "Public Lands: Interior," Part 9212.1, "Prohibited Acts," which says, "Unless permitted in writing by the authorized officer, it is prohibited on the public lands to: … Resist or interfere with the efforts of firefighter(s) to extinguish a fire."

Recent interagency strategy, intended first to persuade UAS operators not to intrude in FTCAs, has led to new policies and procedures; agency familiarization with the characteristics of popular small UAS (also called *drones* or *remotely piloted aircraft*) and the demographics of their operators; analysis of about 33 wildfire-intrusion incidents by operators of small UAS since January 2015; and a campaign to educate the public about this threat and UAS safety in general, says Jessica Gardetto, deputy chief, external affairs, U.S. Bureau of Land Management (BLM) National Fire and Aviation, and the National Interagency Fire Center.

"People maybe don't realize at first exactly how dangerous it is to interfere with wildfire response. They think, 'I've got this little device — how dangerous could it be?' But even a small UAS being sucked into the rotor can cause a helicopter to go down. That would be a very severe situation and definitely an extreme safety issue," she said.

Tightly Confined Airspace

Hazards are inherent because of concentrated aerial firefighting traffic in a confined area even before considering the threat created by an intruding drone.

"The world of wildfires is very complex, especially regarding air traffic," Gardetto said. "In most wildfires, firefighting helicopters, small fixed-wing air tankers, large air tankers, air-attack planes and, sometimes, numerous other types of helicopters are working in different areas over a fire. A lot of these aircraft fly low. For example, helicopters are dropping water on the fire while flying hundreds of feet above the ground, which is the same level at which people fly UAS aircraft.

"Then you have someone who is trying get pictures of the wildfire. From what we have seen — assessing and working to try to determine who buys UAS and who flies them regularly — it's a pretty broad demographic of people. Wildfires are interesting, and we understand that most

Jeffrey McEnroe, U.S. Department of the Interior, Bureau of Land Management|Flickr CC-BY-2.0

operators don't mean any harm. But they don't know that flying UAS aircraft in the area is actually risking the lives of the pilots and the ground firefighters."

The National Interagency Fire Center's database received about 13 reports between January and late June 2016 of small UAS wildfire intrusions in the United States and Canada (see "UAS Intrusions in U.S. Wildfire Airspace in 2016," p. 20). In 2015, at least 20 such flights occurred over or near wildfires in California, Colorado, Oregon, Utah, Wyoming and Washington. During 2015, aerial firefighting operations in these states were temporarily shut down on at least 12 occasions, and two cases of near misses with drones occurred, Gardetto said.

Temporary Restrictions

Training of pilots to fly manned aircraft covers compliance with TFRs whenever issued, for various reasons, by FAA. "For a lot of wildfires, they will issue a TFR for the airspace over the fire. However, there's not always a TFR in place largely because some fires haven't been burning long enough to get through that process for submitting a request for a TFR. That's why we're asking people just to keep those devices as far away from fire as possible regardless of whether or not there's a TFR in place," she said.

What constitutes a safe distance from firefighting operations, for either manned aircraft pilots or small-UAS operators, is difficult to state exactly. "The aerial firefighting traffic over a fire can be coming from any or all directions," Gardetto said. "If you're a member of the public, you could be close enough to interfere, even though you're not technically flying your device over the fire. If you're anywhere near it, you still run the risk of your device colliding with some of the firefighting aircraft because they're coming in and out of the fire. So we're asking people, 'If you see a fire, please do not launch your UAS even if you're miles away, which is hard because people are curious. For the safety of pilots and firefighters, it's just the best call."

Regardless of TFR issuance, air traffic control (ATC) personnel and/or non-ATC airport staff anywhere near a wildfire typically advise pilots of manned aircraft through various standard modes of communication.

"In some cases, firefighting agencies are going to be flying tankers out of a nearby airport or flying within the airport's airspace, so other pilots definitely will be made aware that we have fire traffic in the area," she said. "Our air tankers, helicopters and air-attack planes are always being tracked by FAA air traffic controllers and our automatic flight tracking." If information about aerial firefighting has not been received, the nearest ATC tower or other ATC facility typically is the best source to check, she said.

Similarly, information about extreme weather phenomena generated by wildfires, included in forecasts and current observations (*ASW,* 2/11, p. 35), is readily available to pilots and UAS operators from standard aviation weather sources. "The National Weather Service puts out a fire weather warning to all weather services near the area and/or nationally so that they will know if there's a large column of smoke in the area" or if they're going to be expecting high winds, dry fuel and/or low relative humidity, Gardetto said.

Self-Preservation

The current UAS wildfire-intrusion safety campaign primarily focuses on threats to air and ground firefighters. This argument alone has persuaded some operators to state in internet forum posts that they are heeding the no-fly warnings, and to criticize fellow operators who argue that their photo/video missions cannot be harmful, for example, because they take precautions to avoid manned aircraft at wildfires. The campaign does not focus on the life-threatening risk to UAS operators.

"Although people want to get closer, a wildfire is actually quite a dangerous situation. So we ask the public, 'If you see a wildfire, go the other direction.' Fire can switch direction in a heartbeat — especially if they're in an area experiencing high gusts of wind. You may think it's moving away from you in that case, but the fire can easily overtake you before you know it."

Mandatory Grounding

Situations described in the BLM database of wildfire UAS intrusions show standdowns of aerial firefighting per the national protocol. The protocol's flow charts, checklists and decision points cover suspending aerial firefighting operations, diverting participating aircraft pilots to alternate areas, holding these aircraft at an alternate location and altitude, briefing ground crews and investigating the intrusion — until the air tactical group supervisor (ATGS) is confident that the intruder UAS aircraft has left the area and will not return to the area.

"If there is a UAS aircraft spotted in the area, we have to shut down all air traffic until we determine that the UAS is no longer a threat," Gardetto said. "Unfortunately, in a lot of cases, if we have to shut down air operations, the fire can grow larger because we don't have helicopters making water bucket drops and we don't have air tankers making retardant drops, so it's very detrimental to fire suppression overall." Aircraft transporting an ATGS or surveillance crewmember are similarly affected, typically degrading the real-time intelligence from observers.

The unexpected interruptions of firefighting have many negative impacts for the pilots, not to mention ground firefighters. "Many different aircraft are coming in and out of the area constantly throughout the day," she said. "Firefighters and pilots are already working in an extremely dangerous situation. To add an additional dangerous element is very frustrating to them."

Campaign Update

Since an *ASW* article (*ASW,* 10/15, p. 30) first noted the UAS wildfire-intrusion campaign, officials have reviewed or updated a few aspects. The campaign by the Forest Service — called "If You Fly, We Can't" — has expanded links to public awareness and educational materials, such as extensive multimedia content downloadable from the FAA website <www.faa.gov/uas>. Most importantly, FAA's free smartphone application — called *B4UFLY* — has been released for public use.

"*B4UFLY* is very useful if there is a TFR in an area because people can see it right away," Gardetto said of UAS operators planning flights. "In many cases, they will use that to get their data updated. If there's not a TFR issued for the wildfire, however, that's going to be an issue."

BLM National Fire and Aviation has been working more closely than last year to assist UAS manufacturers that already utilize wildfire TFR data from the FAA for built-in, no-fly geofencing restrictions in their UAS devices, such as DJI <www.dji.com/newsroom/news/dji-fly-safe-system>. Geofencing technology is promising and expected to become especially useful in protecting wildfire operations, Gardetto said.

Also important to the campaign are refinements to data collection and

U.S. Department of Agriculture, Forest Service

analysis by the aviation specialist at BLM National Fire and Aviation who now tracks UAS incursions using all the available data sources.

Within government agencies, BLM National Fire and Aviation also issues alerts called *Safety Nets* to the wildlands aviation firefighting community that consolidate facts from SAFECOMs and related internal analyses, Gardetto said, "The entire wildfire community culture has the aspect of people being able to freely report any safety issue at all, and not face any sort of repercussions or punishment — or even feel embarrassed about it."

Online forums of UAS operators — some at risk of federal enforcement action by posting their UAS-generated footage of wildfires — interest the wildlands aviation firefighting community from the standpoint of gauging how best to reduce intrusions. So far, as noted, appeals to these groups' shared interest in building a reputation for safely flying UAS and minimizing risk of harm to others have resonated, if the posts to forums are to be believed.

UAS Intrusions in U.S. Wildfire Airspace in 2016

The following excerpts of selected briefings about unmanned aircraft systems (UAS) flights, edited by *ASW,* are from a report titled *2016 UAS Airspace Situations Involving Land Management Agencies (Wildfire and Non-Wildfire Included),* submitted June 27, 2016, by the U.S. Bureau of Land Management National Fire and Aviation to the U.S. Federal Aviation Administration (FAA):

Utah, June 19, 2016 — The structure group for the Aspen Wildfire located near Cedar City reported an intrusion into the temporary flight restriction (TFR) area and over the north end of the fire traffic area by a blue and white drone. Air operations were suspended for approximately four hours, then resumed to support fire line personnel. (Aviation Safety Communiqué [SAFECOM] 16-0370)

Utah, June 19, 2016 — Just after the air tactical group supervisor's (ATGS's) aircraft, called the air-attack platform, arrived at the Saddle Fire to assist in a fixed-wing retardant drop mission, a drone passed within 200 ft below and to the right. The platform was at 11,500 ft mean sea level (MSL) and no other firefighting aircraft were in the area. The air-attack pilot climbed, departed the fire traffic area, diverted to Cedar City and landed without incident. The ATGS also canceled missions of all the firefighting aircraft (three large air tankers and four single-engine air tankers, none yet en route) that had been ordered. (SAFECOM 16-0373)

Utah, June 20, 2016 — While performing bucket water-drop operations on the Saddle Fire at about 8,500 MSL, within an active TFR, the firefighting helicopter's pilot and copilot witnessed a white and silver quadcopter flying past the right door roughly 100 ft below them. The ATGS and helibase managers shut down operations and grounded all aircraft for more than one hour while law enforcement officers searched for the UAS operator. (SAFECOM 16-0376)

Nevada, June 21, 2016 — The Washoe County Sheriff's office reported that immediately after a helicopter pilot was released from a holding point 400 ft above ground level for the Hawken Fire near Reno, a small quadcopter drone passed under the nose of the helicopter. The drone missed the helicopter by approximately 50 ft (15 m). During the intrusion, the helicopter was inside the fire traffic area, within 1/4 mile (402 m) of the wildfire. No TFR was in effect. (SAFECOM 16-0385)

California, June 25, 2016 — While performing an air-attack mission as ATGS on the Reservoir Fire, we encountered a drone — a white-rotor quadcopter about 3 ft (0.9 m) square — flying over the fire at 1542 within the TFR. We were operating at 7,500 ft MSL, and the drone was approximately 500 ft below us. After a 30-minute tactical pause per UAS-intrusion procedures, and as we began to resume aircraft operations over the fire, we encountered the drone again at 1627. An airspace coordinator at the FAA air route traffic control center later reported that the UAS operator identified was an individual flying his quadcopter to photograph his burned home and his neighbor's burned home for insurance purposes. (SAFECOM 16-0418)

— WR

Gardetto said the wildfire-related agencies assume typical small UAS operators will appreciate the issues and the seriousness of safety messages.

"We have had people agree strongly with our prohibition of UAS wildfire intrusions when we put things on social media. They make comments like, 'I would never think to do that, but I can also see how someone might not realize that it's a dangerous situation.' But other commenters online are not always in support of the fact that it's a safety issue."

Notes

1. In U.S. terminology, *wildlands* are natural forests, shrub lands, grasslands and other vegetation areas that have not been significantly modified by agriculture or human development. *Wildland fire* means any non-structure fire that occurs in wildlands, including *prescribed fires,* which are planned ignitions by wildland fire authorities, and *wildfires,* which the National Wildfire Coordinating Group defines as "an unplanned ignition caused by lightning, volcanoes, unauthorized, and accidental human-caused actions and escaped prescribed fires."

2. Stein, Susan M.; Comas, Sara J.; Menakis, James P.; Carr, Mary A.; Stewart, Susan I.; Cleveland, Helene; Bramwell, Lincoln; and Radeloff, Volker C. *Wildfire, Wildlands, and People: Understanding and Preparing for Wildfire in the Wildland-Urban Interface.* Rocky Mountain Research Station, U.S. Department of Agriculture Forest Service. General Technical Report RMRS-GTR-299, January 2013.

3. U.S. Department of the Interior Bureau of Land Management, National Park Service, and U.S. Fish and Wildlife Service; U.S. Department of Agriculture Forest Service. *Interagency Standards for Fire and Fire Aviation Operations,* NFES 2724, January 2016.

The U.S. Federal Aviation Administration (FAA), in action that it says will open pathways toward the eventual full integration of unmanned aircraft systems (UAS) into the nation's airspace, has issued a final rule for the routine commercial use of small UAS — those weighing 55 lb (25 kg) or less.[1]

The rule — the first in the United States for commercially operated UAS, also known as drones or remotely piloted aircraft — is designed to "harness new innovations safely, to spur job growth, advance critical scientific research and save lives," the FAA said in announcing its action in late June.

Opening the Skies

In issuing a new rule for operators of small UAS, the FAA is clearing the way for unmanned systems to share the airspace with traditional aircraft.

© sheklma1|iStockphoto

Transportation Secretary Anthony Foxx added, "We are part of a new era in aviation, and the potential for unmanned aircraft will make it safer and easier to do certain jobs, gather information and deploy disaster relief."

Groups representing UAS operators and the aerospace industry called the FAA action a positive step and a "critical milestone" in the process of incorporating UAS into the National Airspace System (NAS).

The rule, Part 107 of U.S. Federal Aviation Regulations, will take effect in late August. It is aimed at operators of small UAS that are being used in "non-hobbyist operations" and designed to "minimize risks to other aircraft and people and property on the ground," the FAA said.

Some of its provisions require operators of small UAS to keep their aircraft within their visual line of sight and to operate them during daylight hours — and during twilight, if the aircraft is equipped with anti-collision lights. Flights are prohibited above "unprotected people on the ground who aren't directly participating in the UAS operation," the FAA said. Some provisions may be waived through an online application process if an operator can prove that a proposed flight could be conducted safely under a waiver, the agency said, adding that, within a few months, waiver applications will be accepted online.

Other provisions say that the person operating the UAS must be 16 years of age or older and must have a remote pilot certificate with a small UAS rating (see "Requirements for a Rating"),

Requirements for a Rating

Before someone may operate a small unmanned aircraft system (UAS) for commercial purposes, he or she must be at least 16 years old and must either have a remote pilot certificate with a small UAS rating or be under the direct supervision of someone who has the certificate and rating, the U.S. Federal Aviation Administration (FAA) says.

Requirements for the remote pilot certificate include passing an aeronautical knowledge test, administered at an FAA-approved knowledge testing center, or possessing an existing non-student pilot certificate issued under U.S. Federal Aviation Regulations Part 61. Applicants who already hold a pilot certificate must have completed a flight review during the previous 24 months and must complete an online FAA training course on UAS.

All remote pilot applicants will undergo a security background check before a certificate is issued, the FAA says.

— LW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"or be directly supervised by someone with such a certificate."

Although small UAS will not be required to comply with FAA airworthiness standards and aircraft certification requirements, the FAA said it will require operators to ensure before beginning a flight that the aircraft are safe. Pilots will be required to conduct a preflight visual inspection and operational check "to ensure that safety-pertinent systems are functioning properly," the FAA said, adding that the operational check will include verifying that the communications link between the control station and the UAS is functioning correctly (see "Major Provisions," p. 24).

"With this new rule, we are taking a careful and deliberate approach that balances the need to deploy this new technology with the FAA's mission to protect public safety," FAA Administrator Michael Huerta said. "But this is just our first step. We're already working on additional rules that will expand the range of operations."

Privacy Education

The FAA said the new rule does not discuss privacy issues associated with the use of UAS but that the agency encourages UAS operators to check state and local laws before using the aircraft systems to gather information through photography or remote sensing technologies.

The FAA said that it also would provide UAS operators with "recommended privacy guidelines, as part of the UAS registration process and through the FAA's B4UFly mobile app" — a smartphone application designed to tell UAS users if the location they have chosen for flight is safe and legal and to provide links to other UAS regulatory sources and other information.

'Clarity on Our Path Forward'

Announcement of the small UAS rule was met with praise from the aviation community.

"The regulations represent the next important step towards routine UAS operations that balance the need for integration of this new technology into the National Airspace System, along with the requirement to develop a culture of safety among UAS operators and the technologies to protect manned aircraft operating at low altitude near airports," said the Aerospace Industries Association (AIA), which represents U.S. manufacturers and suppliers of aircraft and aircraft components.

AIA President and CEO David Melcher added that issuance of the rule "is a positive step that provides industry with clarity on our path forward and allows FAA to focus its resources on developing requirements for beyond line-of-sight operations, the next critical milestone for small UAS."

The Air Line Pilots Association, International (ALPA) praised the rule for its "beneficial safety provisions," including restricting small UAS flights to daytime hours within the operator's line-of-sight and no higher than 400 ft above ground level.

The organization added, however, that it would "like to see the FAA

Major Provisions

Other provisions of the new Part 107 of U.S. Federal Aviation Regulations, which lays out rules for the operation of small unmanned aircraft systems (UAS), say that:

- Small UAS must yield the right-of-way to other aircraft;
- Small UAS must have a maximum groundspeed of 87 kt;
- The maximum altitude for small UAS is 400 ft above ground level (AGL), "or, if higher than 400 ft AGL, [they must] remain within 400 ft of a structure";
- Minimum visibility during flights by small UAS is 3 mi (5 km); and,
- Careless or reckless operations are prohibited, as is carriage of hazardous materials.

— LW

take a stronger stance in ensuring that those who commercially pilot [small UAS] hold the same certificate as commercial-rated pilots. This will assure a standard level of aeronautical knowledge and training across all pilots operating UAS commercially."

In addition, ALPA said the U.S. Congress should "ensure that the FAA has the authority to fully regulate hobbyists and recreational flyers of UAS aircraft. Recreational users make up the bulk of UAS flyers, yet they are virtually unregulated due to legislative conditions placed on the FAA. It is essential that all rules developed to promote the safe operation of unmanned aircraft systems must be consistent with and compatible with those for all other airspace users."

The FAA said that the new Part 107 "codified the FAA's enforcement authority … by prohibiting model aircraft operators from endangering the safety of the NAS" although it does not apply to model aircraft, which are subject to rules developed by the Academy of Model Aeronautics (AMA), a private organization that represents hobbyists who operate model aircraft for noncommercial purposes.

The AMA praised the new rule, which it said would "be highly beneficial to the industry overall." The organization said its members "look forward to seeing widespread commercial and civil operations of unmanned aircraft take flight."

The AMA said it was pleased that the rule maintains an exemption for model aircraft operators from the regulations that will apply to commercial operators of small UAS.

Brian Wynne, president and CEO of the Association for Unmanned Vehicle Systems International (AUVSI), which represents UAS operators, called the new FAA rule "a long-awaited victory for American businesses and innovators" and "a critical milestone" in the process of integrating UAS into the NAS.

"Accelerating civil and commercial UAS operations will not only help businesses harness tremendous potential of UAS, it will also help unlock the economic impact and job creation potential of the technology."

AUVSI estimated that expanding UAS technology could generate more than $82 billion for the U.S. economy over the next 10 years and create more than 100,000 new jobs.

"Whether it's aiding search-and-rescue missions, advancing scientific research, responding to natural disasters or helping farmers care for their crops, UAS are capable of saving time, saving money and, most importantly, saving lives," AUVSI said.

5,000 Commercial Users

Before issuance of the rule, UAS operations were limited by the FAA, but more than 5,000 commercial users nationwide have been granted exemptions to operate UAS for specific purposes and under specified conditions. Government entities have been able to apply for a certificate of waiver or authorization (COA) to operate a UAS in civil airspace — typically for law enforcement, firefighting, border patrol, disaster relief, search-and-rescue, military training and other FAA-approved operations.

The FAA also has granted regulatory exemptions to allow UAS to be used in defined categories of activities such as aerial surveying, monitoring construction sites, inspection of oil rig flares, and engaging in aerial news photography/videography and production of films and television programs.

Other operations, largely research-oriented, have been conducted at six FAA-designated test sites across the country and through the agency's UAS Center of Excellence, made up of 22 research institutions and dozens of partners from government and industry that have examined the use of UAS in such areas as hurricane forecasting, precision agriculture and aiding navigation through Antarctic ice.

Note

1. The full text of the Part 107 Rule is available at <www.faa.gov/uas/media/RIN_2120-AJ60_Clean_Signed.pdf>.

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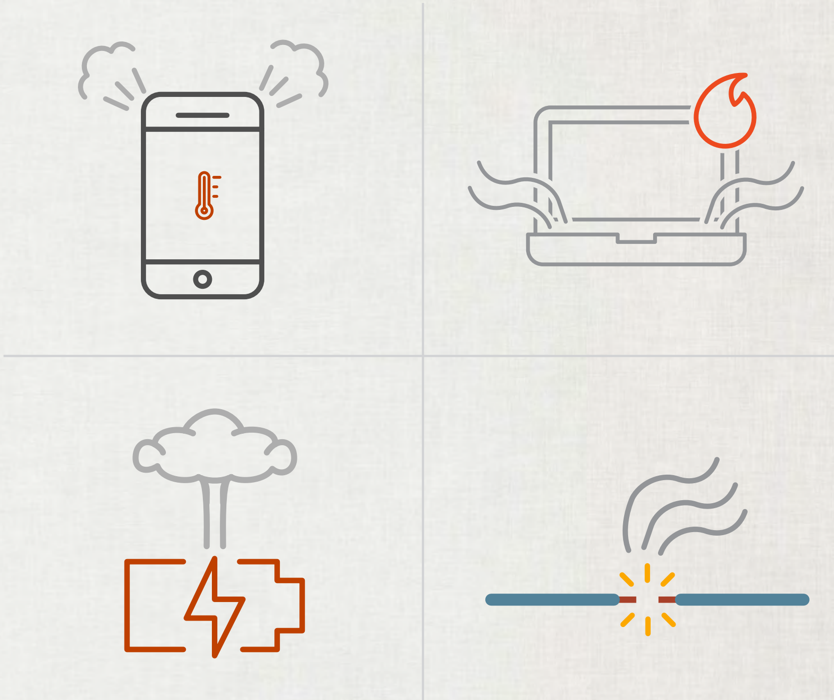

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AIR ANALYSIS

More information is needed to enable the analysis of health risks associated with contaminants in bleed air, an FAA report says.

BY LINDA WERFELMAN

Despite years of research, aeromedical specialists lack the information they need to quantify the potential health risks of exposure to bleed-air contaminants in airplane cabin air, a report for the U.S. Federal Aviation Administration (FAA) Civil Aerospace Medical Institute (CAMI) says.[1]

The report, which focused on exposure to bleed-air contaminants generated during "fume events" in pressurized aircraft, obtained information from existing literature that dealt primarily with the presence of carbon monoxide, carbon dioxide, ozone, volatile and semi-volatile organic compounds and airborne particles. The author determined that the information was insufficient to enable him to form any conclusions.

"Quantification of the potential health risks associated with exposure to bleed-air contaminants in cabin air is not possible without broad identification and measurement of the representative hazardous constituents of bleed air during contaminated air events," the report said. Carrying out a 2012 U.S. law[2] that

Composite image: Jennifer Moore
Cabin image: © Jan Severijns | Air Team Images

mandated analysis of the issue requires funding for research, the report added.

The quality of cabin air has been a concern for at least 30 years, the report said, noting that hearings conducted before subcommittees of the U.S. Congress in the 1980s yielded contradictory information about cabin air quality, along with a mandate for research into the subject. A subsequent study, conducted in 1986 by the National Academy of Sciences, found "a lack of data for a scientific evaluation of aircraft cabin air quality and associated health effects," the CAMI report said, noting that the same 1986 study recommended banning cigarette smoking on commercial flights — a recommendation that was implemented, in part, the following year.[3]

A number of additional studies followed, but their conclusions have been inconsistent and they have regularly called for continued research, the CAMI report said.

Sources of Cabin Air

Aircraft cabins and cockpits receive fresh air from outside. Typically, the outside air enters a large aircraft's environmental control system (ECS) through the aircraft engines. This air is "bled" through ports and this *bleed air* is cooled before being mixed in a manifold with recirculated air and then distributed throughout the aircraft.[4]

Fume events, also known as contaminated-air events, often occur when incoming air encounters oils or hydraulic fluids that have escaped from leaking seals in the aircraft engines or from leaks in auxiliary power units (APUs).

"Such events arising from the ECS and/or APU are considered non-routine and extremely rare," the report said. "Factors inside the engine compartment that influence the generation of contaminants include types and amounts of oil and hydraulic fluids, temperature and humidity. Factors inside the aircraft that influence contaminant concentrations include the size of the occupied space and the number of complete air changes per hour (i.e., the volume of make-up air versus the volume of exhausted cabin air)."

The report defined the word *fume* as "any noxious gas, smoke or vapor in the atmosphere" and added that a *fume event* referred to "a potentially toxic environment created by contaminated bleed air." However, that characterization does not fully describe the event in scientific terms, the report said, because "additional constituents" may be present in the atmosphere, including gases, vapors, smoke and mist.

"No matter how such an event is described, contaminated bleed air should be regarded as a heterogeneous mixture of many possible constituents, the exposure to which may result in a spectrum of adverse health effects," the report said, citing 2011 research.[5] "Recirculated air in an aircraft cabin likely also contains a number of anthropogenic constituents introduced, in part, by crew and passengers. These contaminants may include dusts and fibers, as well as a variety of bioaerosols such as microorganisms, bacterial cells, fungal spores, pollen grains, skin scales and viruses."

The report noted that bleed air is "cooled but not cleaned" before it is mixed with recirculated cabin air; recirculated air passes through high-efficiency particulate air filters, which remove particles, but not gases or vapors.

Potential Health Problems

Gases from bleed air found in the contaminated cabin air include carbon monoxide from engine exhaust, carbon dioxide from incomplete combustion, and ozone, which originates in the atmosphere and may enter an aircraft through the ECS.

Exposure to carbon monoxide can result in anemic hypoxia, although the level of the substance found inside an aircraft usually is lower than that associated with health problems, the report said.

Carbon dioxide exposure can result in headache, dizziness, restlessness and, at its worst, asphyxia — an extreme lack of oxygen in the blood that can lead to death. The report cited earlier research that noted carbon dioxide levels in pressurized aircraft ranging from 515 to 4,902 parts per million, compared with the limit recommended by the U.S. National Institute of Occupational Safety and Health (NIOSH) of 5,000 parts per million.

Ozone exposure can cause irritation of the eyes and mucus membranes, as well as chronic respiratory disease, the report said. U.S. Federal Aviation Regulations specify that ozone concentrations inside aircraft cabins should be no more than 100 parts per billion "for any three-hour period when the aircraft is above 27,000 ft" and no more than 250 parts per billion above 32,000 ft, and NIOSH recommended a maximum exposure of 100 parts per billion. The amount of ozone measured in commercial aircraft varied considerably, the report said, citing one series of peak-hour measurements that ranged from three to 275 parts per billion.

The report also noted that earlier research found that ozone reacts with seat fabrics, carpets, plastics, clothing and other materials in airplane cabins, emitting volatile organic compound (VOC) byproducts, which have been associated with damage to the liver, kidneys and central nervous system; some VOCs have been identified as suspected or known carcinogens.

"We must recognize that health risks to aircraft occupants may occur from not only exposures to [carbon monoxide, carbon dioxide] and other bleed-air contaminants but also from exposures to [ozone] and [ozone]-reactive byproducts," the report said.

The report said that the 1986 report on the subject by the National Academy of Sciences found no earlier studies that measured detectable concentrations of VOCs or semi-volatile VOCs in cabin air. A 2002 report said that few data existed, and a 2012 report said that "the specific nature and extent of potential decomposition reactions of engine oils and hydraulic fluids are largely unknown" and that "the resulting nature and potential toxicity of any contaminants in the aircraft cabin from such events are highly speculative."

The report said that, under the 2012 law, considerable research still must be conducted in several areas, including the following:

- "The ongoing study of air quality in aircraft cabins through a comprehensive sampling program for broad characterization and evaluation of the constituents of contaminated bleed air;
- "Assessment of bleed air quality on the full range of commercial aircraft operating in the U.S.;
- "Continued assessment of health risks to passengers who may be exposed during bleed air events;
- "Continued development of instrumentation for sensing bleed air [contamination] and cleaning contaminated air in pressurized aircraft cockpits and cabins;
- "Continued development and evaluation of current measurement technologies both on the ground and in flight; and,
- "Development of a systematic reporting standard for contaminated bleed-air events."

Spelling out the potential health risks associated with exposure to bleed-air contaminants will not be possible "without broad identification and measurement of the representative hazardous constituents of bleed air during contaminated air events," the report concluded. "Carrying out such a mandate requires adequate funding to support research activities."

Notes

1. Day, Gregory A. Report No. DOT/FAA/AM-15/20, *Aircraft Cabin Bleed Air Contaminants*. Oklahoma City, Oklahoma, U.S.: FAA Civil Aerospace Medical Institute. November 2015.
2. Public Law 112-95 directed the FAA to study cabin air quality to evaluate bleed air quality in commercial aircraft in the United States, to identify toxins in bleed air, to determine what level of toxic fumes presents a health risk to passengers, to develop a systematic reporting standard for smoke and fume events and to identify potential health risks to anyone exposed to toxic fumes during flight.
3. The 1987 law prohibited smoking in passenger cabins and lavatories during flights of two hours or less.
4. The report noted that Boeing 787s are exceptions, directly introducing fresh air through a dedicated air inlet.
5. The report cited two reports by A.K. Chaturvedi: "Aerospace Toxicology: An Overview," Report No. DOT/FAA/AM-09/8, published by the FAA Office of Aerospace Medicine, and "Aerospace Toxicology Overview: Aerial Application and Cabin Air Quality," published in *Reviews of Environmental Contamination and Toxicology*.

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FSF Editorial Staff. "Cabin-Air Contamination Briefly Incapacitates Crew." *Cabin Crew Safety* Volume 37 (January–February 2002): 1–4.

Brave New World

FAA simulator requirements enable acceptably realistic recoveries from full stalls and upsets in commercial jets.

BY WAYNE ROSENKRANS

International efforts to eradicate loss of control–in flight (LOC-I) in large commercial jets through pilot training have reached a favorable tipping point this year, a number of stakeholders agree. The reason is that advances in flight simulation training devices (FSTDs), while still awaiting detailed regulatory mandates to industry from nearly all national or regional civil aviation authorities, will furnish the technical piece that has been missing for widely implementing airplane upset prevention and recovery training (UPRT).

Among significant evidence of progress is the latest decision in the United States, announced March 30, on exactly how FSTDs must be modified to model certain elements of UPRT with acceptable levels of fidelity, such as providing airline pilots with hands-on experience in full-stall

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Thales RealitySeven Level D full flight simulator

recoveries in their aircraft. A number of subject matter experts expect the U.S. precedent in UPRT regulatory implementation to pave the way for other states, airlines and aviation training organizations (ATOs) to introduce UPRT as quickly as their resources allow, within timeframes that their civil aviation authorities impose.

AeroSafety World last year described the Federal Aviation Administration's (FAA's) draft proposals for new capabilities of FSTDs (a term including *full flight simulators* [FFS] and *flight training devices*) to be required in U.S. airline pilot training (*ASW,* 4/15, p. 30). Underlying national policy changes had taken effect in March 2014.

Now, FAA's completed set of regulations shows a way to incorporate the various UPRT standards and recommended practices published by the International Civil Aviation Organization (ICAO), most wholly and some partly, with explanations of the modifications deemed necessary by the agency as it responded to a 2010 airline safety law passed by the U.S. Congress.

FAA's final rule amending Federal Aviation Regulations (FARs) Part 60, *Flight Simulation Training Device Qualification Standards for Extended Envelope and Adverse Weather Event Training Tasks,* details the changes that U.S. airlines and ATOs, with oversight by FAA inspectors, must implement no later than March 12, 2019.[1]

For context, the U.S. airline industry looks forward to UPRT succeeding as the predominant LOC-I risk mitigation for the present time, while teams of scientists engaged in other types of research and development say they anticipate that technological risk mitigations on flight decks eventually will complement UPRT.

Implementation Insights

At the international level, full stalls and unintended attitude excursions have been treated as an integral part of UPRT, according to one update on implementation efforts presented in January 2016 to a conference of the American Institute of Aeronautics and Astronautics.[2] FAA says in Advisory Circular [AC] 120-111, *Upset Prevention and Recovery Training,* "Although a stall is by definition an upset, stall prevention and recovery training is contained in [AC 120-109A], *Stall Prevention and Recovery Training.* … In addition to stall training, UPRT is an essential training element to reduce loss of control events or, if they occur, enable recovery to normal flight."

Authors Sunjoo Advani, president, International Development of Technology, and Jeffery Schroeder, chief scientific and technical advisor, flight simulation systems, FAA, said UPRT implementation by airlines worldwide is now occurring at a rapid pace for several reasons: ICAO's standards and recommended practices and their adoption under way into state-level aviation regulations; recurrence of LOC-I incidents and accidents, prompting urgent UPRT implementation by the airlines involved and by others; airline flight data monitoring analyses that underscore the need for UPRT; and wide acceptance of FSTD-based and human factors–based solutions. The flight data may prompt studies, for example, of stall warnings, overspeed warnings, bank-angle exceedances, wind shear events and sink rate warnings from ground-proximity warning systems, problems in automation handling, and tail strikes.

"Both regulation and an impetus to maintain high safety levels are driving airlines to rapidly deploy UPRT," they said. "However, some airlines have also had recent upset-related events, and are embarking on safety enhancement programs involving UPRT. For example, an All Nippon Airways Boeing 737 encountered an overbank upset during a routine flight, due to an inadvertent rudder trim application by a pilot. A Chinese operator encountered a stall in an Airbus A320 during an approach in severe weather. AirAsia [experienced] a fatal A320 LOC-I accident in 2014."

They traced today's implementations partly to seven years of UPRT work by the International Committee for Aviation Training in Extended Envelopes, which had "determined that 56 percent of the training footprint could be covered by knowledge and with better use of today's Level D/Type 7 simulators, without modification. With enhancements to these devices (instructor station feedback, better matching of stall-related buffet and validated post-stall [aerodynamic] modelling), nearly 85 percent of the training requirements could be achieved. This would cover the [airplane stall/upset] recovery portion as well."

Their paper summarized the globally influential UPRT rulemaking by FAA and the European Aviation Safety Agency (EASA). "For the purpose of global harmonization, hopefully the final EASA regulations will be harmonized with the FAA rules for UPRT," Advani and Schroeder said.

Full Stall Exposure

"Stalls have proven to be a major contributor in airplane upsets, possibly due to their unpredictable nature or the challenges that they pose: the 'roll off' could cause the pilot to be distracted and to counteract the roll while stalled through aileron inputs, as occurred in the Colgan [Air Flight] 3407 crash in 2009 [*ASW,* 3/10, p. 20]. In fact, the sole action should be to reduce the angle-of-attack, followed by rolling the wings to level and stabilization of the flight path," they said.

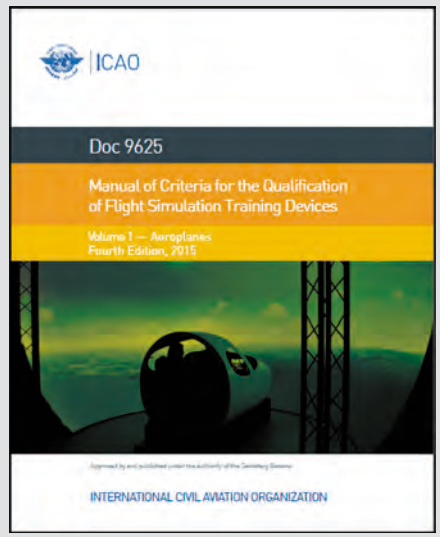
The concept of upgrading FSTDs to sufficient realism for full stalls and other UPRT maneuvers still leads to confusion among some pilots. "First, it is important to know that the upset definition does not mean that a simulation model is outside its validated [training] envelope during every upset," they said. "However, additional modeling or validation of the aircraft model may be required in the proximity of the stall, or other parts of the flight envelope. Near the stall, transport aircraft may demonstrate deterrent buffet, reduced control effectiveness, reduced damping, Mach effects, rapid and possibly uncommanded departures from the flight path, activation of stall warning/stick shaker, activation of envelope protection/stick pusher, or any combination thereof. These are covered by [the latest amendment of FARs Part 60]."

Airlines ready to implement UPRT while waiting for applicable regulations particularly are facing limited availability of qualified UPRT instructors and problems obtaining valid simulator data for the required FFS upgrades, Advani and Schroeder said. Some pilots have found the following FSTD scenarios to be among the most valuable to them: pitch runaway during takeoff; nose-low stall; traffic-alerting and collision avoidance system alert at high altitude; inadvertent stall warning, such as stick shaker activation; recovery from overbank; unreliable airspeed; and power-off stall, they added.

They also reiterate the point that extreme care must be taken during implementation, adding, "It is most important that airlines apply UPRT in a safe manner, by consulting with the airframe manufacturer, developing knowledge on the applicable regulations, and adequately training their instructors to conduct UPRT effectively and with minimum chance of instilling potentially dangerous habits in their pilots."

Diverse Perspectives

Another expert observer of implementation efforts, Mark Dransfield, chairman, training devices work stream, International Pilot Training Consortium (IPTC), told the World Aviation Training Conference and Tradeshow (WATS 2016) in April that writing state-level regulations has taken too long.[3] "In [the fourth edition of ICAO Document] 9625, we defined criteria to make it simpler for [civil aviation authorities] globally to easily evaluate different FSTD solutions [in relation] to different training syllabi and competency-based training needs without prescribing the technical solution or trying to make them all fit current regulatory-defined types," the presentation said.



Until FAA finalized the Part 60 amendment, only the Civil Aviation Authority of Singapore had fully implemented UPRT regulations using ICAO Doc 9625 Third Edition over the six-year period since its adoption, according to Dransfield.

Other presenters at this conference agreed that national and regional governments' pace of implementation of UPRT regulations is the major current challenge.[4] In the United States, the preparations partly involved training all FAA inspectors who approve airline training, according to Robert Burke, manager, air carrier training systems for the FAA Air Transportation Division, and FAA's Schroeder. Their presentation said that the agency's new inspector training course was beta-tested with 100 airline pilots, and yielded a sense of the questions that will arise and the misconceptions that may persist.

Burke and Schroeder pointed out two of the most problematic comments of the "top 10" received by FAA personnel from the UPRT beta-test pilots. One was, "If stalled, I need to add full power first." The other was, "I should still power out of a stall down low." Both run counter to current standards of full-stall recovery and UPRT.

Moreover, these beta-test pilots, representing pilots of large commercial jets, expressed doubts, before taking the course, about the capability of FSTDs to realistically fly a full-stall demonstration, about the need for such training and about the possibility of negative learning occurring in airplane types that have automation protecting against departure from the normal flight envelope.

IATA's Guide to UPRT

A large library of relevant documents, as of mid-2016, explains in detail how civil aviation authorities should write UPRT regulatory requirements, and how airlines should implement them. In light of these interrelated multi-source documents, the International Air Transport Association's (IATA's) Pilot Training Task Force has made efforts to simplify and accelerate implementation by airlines by sharing practical knowledge and experience of early implementers. "The ideal UPRT program structure should … be designed as a coordinated effort between the operator and the ATO," IATA's guide[5] says while providing background on FSTD terminology such as *valid training envelope* and *normal flight envelope,* and its relevance to UPRT.

The guide notes, "Exercises outside the valid training envelope can create misperceptions, as the FSTD's simulation model may not satisfactorily represent the airplane behavior. … In order to provide the full scope of UPRT to their pilots, ATOs and operators should consider implementing the necessary FSTD improvements without undue delay."

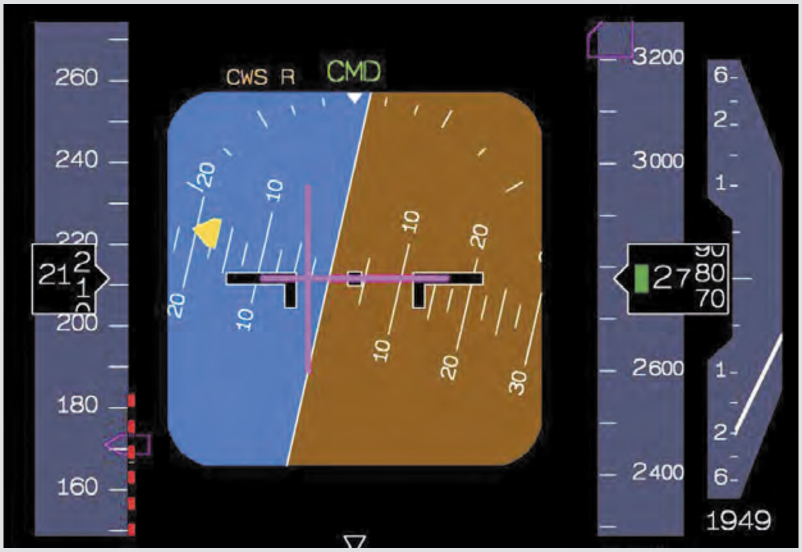
Technological Interventions

Paralleling the implementation of UPRT (including full-stall training), other teams of researchers envision LOC-I mitigation possibilities by optimizing flight crews' airplane state awareness through cutting-edge automation. One such research initiative responds to a U.S. Commercial Aviation Safety Team safety enhancement that emerged from the team's concentration on the precise role of airplane state awareness in LOC-I accidents.

The idea, essentially, is for software algorithms to predict and assess future airplane energy states relative to a safe flight envelope and autoflight configurations, and to inform or alert pilots when problematic autoflight inputs or conditions occur, according to the overview from the researchers involved.[6]

"The combination of prediction and assessment technologies [is] used to trigger timely alerts to avoid loss-of-control situations. The maneuvering envelope limits are also indicated on the primary flight display, and the predicted [four-dimensional] trajectory is displayed on navigation and vertical situation displays. … These tools seek to make the behavior of the automation more transparent to the flight crew,

Some upsets involving large commercial jets revealed inattention or improper response to data on typical primary flight displays, prompting renewed efforts at technological mitigations.



U.S. Federal Aviation Administration

while enhancing their energy state awareness, and alerting pilots of problematic autoflight inputs or conditions," their paper said.

"The display features and alerts were evaluated in the Advanced Concepts Flight Simulator at the [U.S. National Aeronautics and Space Administration] Ames Research Center, where commercial airline crews [20 Boeing B757/767 pilots from three airlines] flew multiple problematic approach and landing scenarios to investigate the impact on current and future aircraft energy state awareness. … Scenarios were specifically constructed to induce high- and low-energy situations, as well as to imitate failures and other off-nominal conditions based on previous accidents and incidents. … Each scenario was flown twice: once with the new display and alerting technologies, and once without. … Results show that the display features and alerts have the potential to improve situational awareness of what the automation is doing now and what it will do in the future. … Trajectory prediction and maneuvering envelope estimation can rapidly assess the safety of the future state of the aircraft and be combined to provide predictive alerts to flight crews. … These technologies show potential in enhancing automation and energy state awareness, but there are still limitations and much room for improvement."

Necessary Differences

The rulemaking to enhance FSTDs in the United States varies somewhat from that of other countries and regions because of origins in the new airline pilot qualifications required by the 2010 law, which specified training broader than UPRT for "rare, but high-risk, scenarios." The amended Part 60, for example, defines simulator fidelity requirements for a variety of specific new training tasks to be conducted in Level A through Level D FFS within air carrier training programs.

An example of a resulting difference is that FAA regards the following elements as the only criteria that pilots will use in an FSTD to identify a stall: "No further increase in pitch occurs when the pitch control is held on the aft stop for 2 seconds, leading to an inability to arrest descent rate. An uncommanded nose-down pitch that cannot be readily arrested, which may be accompanied by an uncommanded rolling motion. Buffeting of a magnitude and severity that is a strong and effective deterrent to further increase in AOA. The activation of a stick pusher."

The regulation similarly says, "All pilots operating under Part 121 must complete flight training in a Level C or higher full flight simulator on the following maneuvers and procedures during initial, transition, upgrade and recurrent training: manually controlled slow flight, manually controlled loss of reliable airspeed, manually controlled instrument departure and arrival, upset recovery maneuvers, recovery from bounced landing and recovery from full stall and stick pusher activation, if equipped."

The regulation also responds to the source law's requirements for maneuvers conducted in airborne icing conditions, takeoff and landing maneuvers in gusting crosswinds, and bounced-landing recovery maneuvers.

As to spillover effects upon all kinds of FSTD training as a result of amending Part 60, FAA noted, "The requirements … will also have an added benefit of improving the fidelity of all FSTDs initially qualified after the final rule becomes effective. … These changes will ensure that the training and testing environment is accurate and realistic, will codify existing practice, and will provide greater harmonization with international guidance for simulation."

Notes

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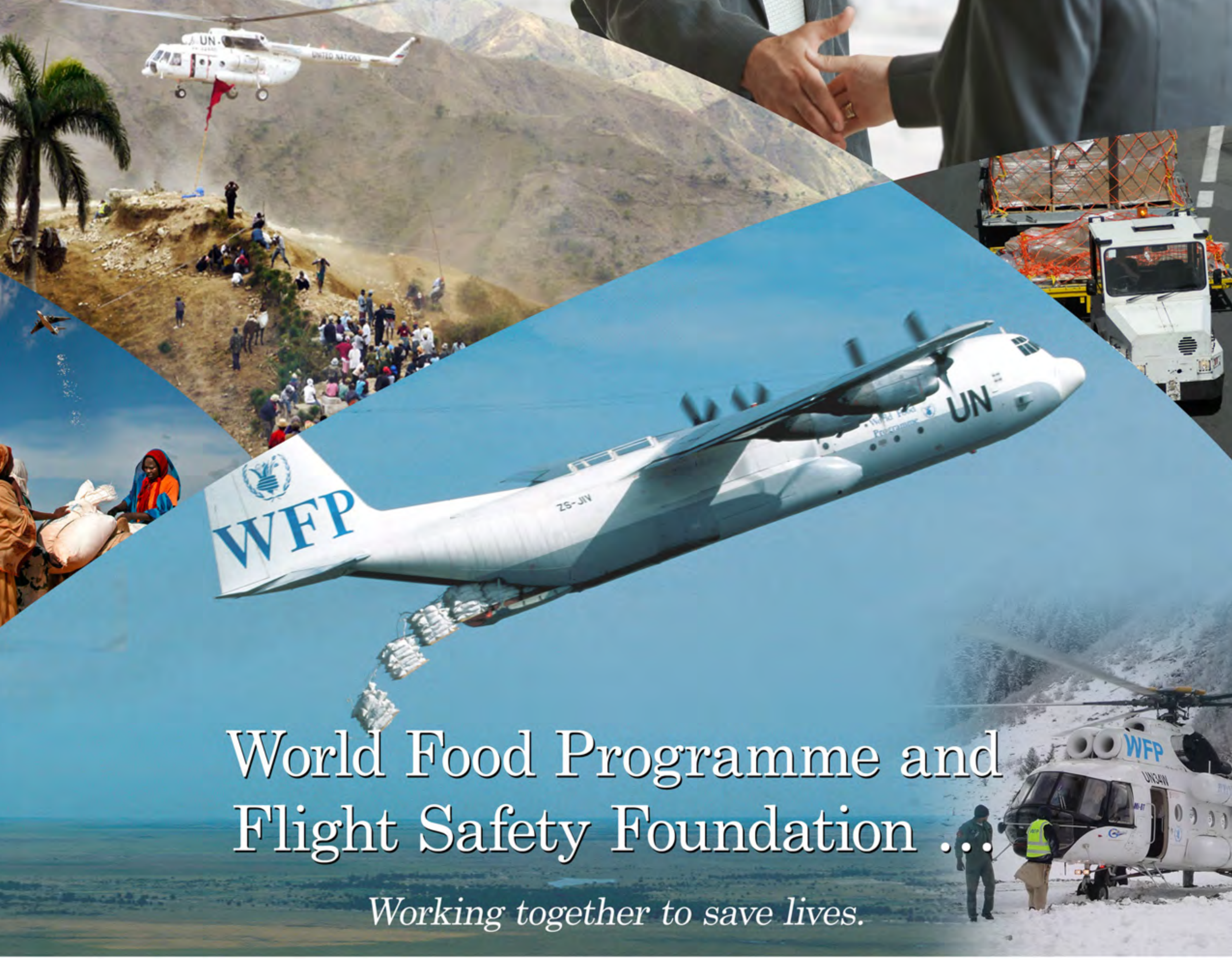
2. Advani, Sunjoo K., and Schroeder, Jeffery A. "Global Implementation of Upset Prevention and Recovery Training." Paper presented by Advani, Schroeder and Bryan Burks, an Alaska Airlines captain, to the AIAA Modeling and Simulation Technologies Conference, American Institute of Aeronautics and Astronautics (AIAA) SciTech 2016, Jan. 4–8, 2016, in San Diego. <arc.aiaa.org/doi/abs/10.2514/6.2016-1430>.
3. Dransfield, Mark. "Flight Simulator Training Device Regulations and ICAO 9625." Presentation to the World Aviation Training Conference and Tradeshow (WATS 2016), April 18–21, 2016, Orlando, Florida, U.S.
4. Burke, Robert, and Schroeder, Jeffery. "Impact of Upcoming Stall/Upset Requirements in the U.S." Presentation to WATS 2016, April 19, 2016.
5. IATA. *Guidance Material and Best Practices for the Implementation of Upset Prevention and Recovery Training.* First Edition, June 2015.
6. Shish, Kimberlee; Kaneshige, John; Acosta, Diana; Schuet, Stefan; Lombaerts, Thomas; Martin, Lynne; and Madavan, Avinash N. "Trajectory Prediction and Alerting for Aircraft Mode and Energy State Awareness." Paper presented to the AIAA Modeling and Simulation Technologies Conference, AIAA SciTech 2016. <dx.doi.org/10.2514/6.2015-1113>.



The World Food Programme (WFP) is the food aid branch of the United Nations, and the world's largest humanitarian organization. WFP provides food to about 90 million people each year, including 58 million children. From its headquarters in Rome and offices in more than 80 countries, WFP helps people who are unable to produce or obtain enough food for themselves and their families.

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For more information on how you can help, contact Susan Lausch in the FSF Development Department at lausch@flightsafety.org or phone +1.703.739.6700, ext. 112.

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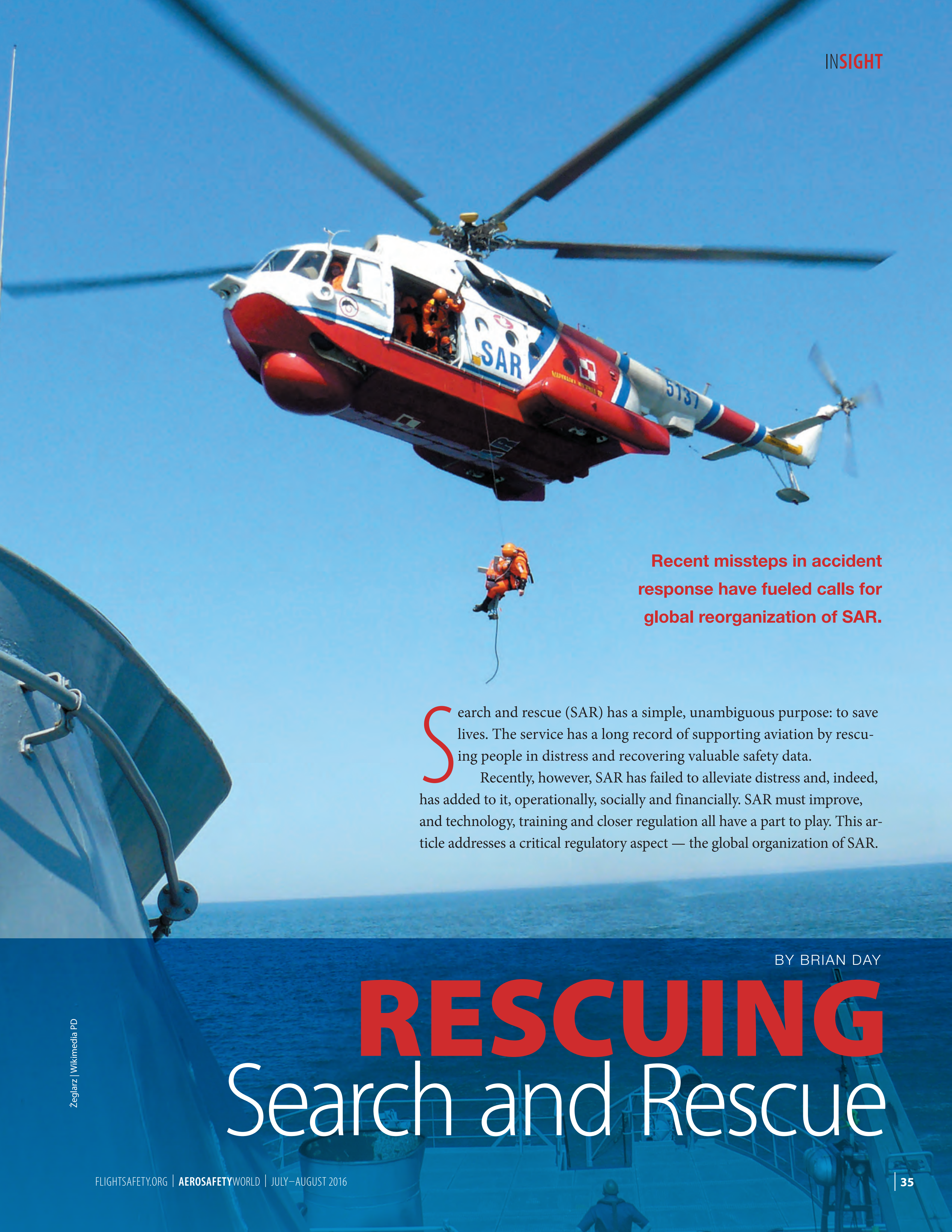

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Recent missteps in accident response have fueled calls for global reorganization of SAR.

BY BRIAN DAY

RESCUING Search and Rescue

Search and rescue (SAR) has a simple, unambiguous purpose: to save lives. The service has a long record of supporting aviation by rescuing people in distress and recovering valuable safety data.

Recently, however, SAR has failed to alleviate distress and, indeed, has added to it, operationally, socially and financially. SAR must improve, and technology, training and closer regulation all have a part to play. This article addresses a critical regulatory aspect — the global organization of SAR.

The functions of SAR are to:

- Plan and coordinate aerial searches;
- Devise and coordinate rescue operations;
- Provide flight dispatch services, separation of aircraft and flow of traffic;
- Oversee the safety of operations;
- Provide medical and life support to survivors; and,
- Evacuate survivors to a place of safety.

In SAR actions of any magnitude, scarcely any state provider can act alone because few have sufficient resources. SAR customarily makes use of others' assets for its highly specialized missions. Using others' air and sea craft requires careful communication, tight coordination and close collaboration.

Expertise is called for from many sectors, including communication, surveillance, medical, police, military, security and diplomatic. Effective application of such diverse input demands close adherence to SAR plans that are carefully, cooperatively and pre-emptively prepared. Coordination is key, both in the preparation of plans and in their implementation.

A State Obligation

In the civil aviation context, SAR is an essential member of the family of air navigation services mandated by the 1944 Chicago Convention, also known as the Convention on International Civil Aviation; its provision is a legal obligation of all member states of the International Civil Aviation Organization (ICAO).

The Convention requires cross-border cooperation and coordination in SAR. While this is an operational necessity, it presents a significant diplomatic challenge as well.

Whether SAR is provided rapidly and effectively depends on early decisions and actions by air traffic controllers.[1] When any aircraft on their frequency encounters an emergency, controllers — as a function of in-flight emergency response (IFER) procedures — are required to alert the SAR service by declaring a "SAR phase." This phase categorizes the gravity of an aircraft's emergency situation and can be either an *uncertainty phase* (indicating doubt about an aircraft's safety), an *alert phase* (indicating apprehension) or a *distress phase* (indicating reasonable certainty of grave and imminent danger).

Air traffic control (ATC) must immediately notify the declaration of each SAR phase to the rescue coordination center (RCC).

Upon notification, the RCC evaluates the SAR phase, gathers more intelligence and, if necessary, either alerts SAR facilities or activates the SAR system.

If ATC fails to declare a SAR phase or to notify the RCC of its declaration, the RCC may remain unaware of the emergency, and as a result, take no SAR action.

Air France Flight 447

TASIL is a waypoint on the Atlantico Flight Information Region (FIR)[2] boundary en route from Rio de Janeiro to Paris. On June 1, 2009, the crew of Air France Flight 447, an Airbus A330 bound for Paris with 228 passengers and crew, failed to report passing TASIL at its estimated time of arrival of 0220. ATC should have begun communication checks by 0223, but this was not done.[3]

When the aircraft crew failed to resume radio contact, ICAO procedures required ATC to declare the uncertainty phase and to notify the RCC. This, too, was not done.

When the aircraft failed to report at its next designated reporting point, an upgraded alert phase should have been declared and the RCC notified accordingly. Again, this was not done.

At 0834, 6 hours and 14 minutes after the loss of communication with the aircraft, a distress phase was declared — belatedly, and impossibly late for effective life-saving intervention by SAR services — and the RCC was notified.

By 0940, some operational search decisions were being made, not by trained and experienced SAR coordinators, but by unqualified senior government personnel outside the operational domain.

The first search aircraft left Dakar, Senegal, at 1214, about 10 hours after the loss of communication.[4] Search aircraft were allocated to different areas, in separate jurisdictions, by separate authorities, in uncoordinated searches and with no common radio frequency. This was, in part, because operational intelligence was being communicated and aircraft allocations were being negotiated through diplomatic channels, not between RCCs.

In its initial investigation, the French Bureau d'Enquêtes et d'Analyses (BEA) found that a key SAR provider had made repeated but ineffective contact with other emergency centers that were neither required nor competent to coordinate aviation SAR activity. Further, after hours of inaction by its down-route counterparts, a properly designated SAR provider "wondered whether it would be appropriate to launch an alert." Another RCC said that it was not qualified to intervene because the event was outside its zone of SAR responsibility.

If effective communication is the lifeblood of an interdependent

© Peter Gronemann | Flickr CC-BY 2.0

operational system, the SAR system had hemorrhaged. Core evidence is that the last known aircraft communications addressing and reporting system (ACARS) position of the aircraft was "lost" in the distribution of data among centers. Nothing is of more importance to search planning than the last known position of the distressed aircraft.

Unsurprisingly, the search did not proceed well. No regional SAR plan was implemented; indeed, none had been developed. The effort was neither sufficiently coordinated nor communicated, and offered little probability of timely detection of the missing airplane.

Regional SAR Plans

Regional[5] SAR plans are vital. They list the responsibilities and functions of all participants within cooperating states and include databases of such resources as search craft and their terms of availability, on-board equipment, droppable supplies and crew complements. The plans also must include current contact details for communication facilities, meteorological offices, counterpart emergency providers, airlines, key government personnel and so on.

Regional SAR plans cannot be instantly developed at the time of distress. They need to be pre-emptively negotiated and agreed upon by all participants, documented, authorized, practiced and regularly updated. Without these plans, any responses to major emergencies that cross sovereign borders are likely to be shambolic.

In the case of Flight 447, it was not until five days after the search began that bodies and debris were found floating at sea. After 26 days and an estimated cost of $105 million, the surface search was discontinued.

The underwater search for the hull continued for another two years.

In all, the cost of the surface and underwater searches is estimated at $145 million.

An acceptable level of safety requires, by definition, constant considerations of cost-benefit. When all hope of saving lives is lost, a fundamental question arises: If safety — and, by extension, the recovery of safety data — is a core business function and subject to balanced financial assessment, at what point should expenditure on search activity be considered unviable?

UPS Flight 6

Twenty-two minutes after departing from Dubai, United Arab Emirates, for Cologne, Germany, at 1851 on Sept. 3, 2010, the crew of UPS Flight 6, a Boeing 747-400, reported a fire on board.[6] The aircraft was near the midpoint of the Arabian Gulf, close to the three-way confluence of the Bahrain, Emirates and Tehran search and rescue regions (SRRs).[7]

Bahrain ATC, in providing IFER assistance, advised the crew that Doha, Qatar, was the nearest suitable airport, 100 nm (185 km) away at their 10 o'clock position. Dubai was 148 nm (274 km) away. The crew opted to return to Dubai and remained on Bahrain ATC frequency. In-flight conditions deteriorated quickly, and smoke on the flight deck severely hampered instrument visibility. The crew transmitted a mayday message, but no SAR phase was declared by ATC, and, consequently, no RCC was notified.

The airplane was high and fast when it arrived overhead Dubai airport. It overshot the field and continued southeast before descending steeply and striking the ground at 1942 near Al Minhad Air Base. Both crewmembers, the only occupants, were killed. Having crashed on land close to Dubai, there was no searching to be done; there being no survivors, there was no opportunity for any rescue.

It is salient from a SAR perspective that if the aircraft had crashed or ditched in the Gulf, it could have occurred in any one of the Bahrain, Emirates or Tehran SRRs. An effective SAR response would have required rapid and extensive coordination between ATC and SAR, the aviation and maritime emergency services, civil and military sectors, neighboring states' diplomatic authorities and many supporting entities. However, far from such coordination being effected, the essential first step of SAR procedures — the declaration of a SAR phase — was never taken and, consequently, no RCC was ever notified, not at the declaration of the emergency or even at the time of the crash.

The areas of SAR jurisdiction in the Gulf are small and closely adjacent, so any major SAR action is likely to require rapid communication and close cooperation among multiple states and authorities. Nevertheless, no regional SAR plan had been developed, and no interstate letters of agreement had been approved to establish high-level principles of operational cooperation.

In a region as fraught with international discord as the Gulf, where diplomatic approvals for cross-border activity are subject to necessarily close scrutiny, pre-emptive agreements for unimpeded access to accident victims across borders are critical.

Malaysia Airlines Flight 370

Like Air France Flight 447, Malaysia Airlines Flight 370 — a Boeing 777 that disappeared on March 8, 2014, en route from Kuala Lumpur, Malaysia, to Beijing with 239 passengers and crew — vanished near an FIR boundary; this time, the boundary between the Malaysian and Vietnamese areas of ATC/SAR responsibility.[8] Once again, there were shortcomings in IFER, SAR alerting and RCC response. These breakdowns, too, were most apparent at points of interface between participating sectors: ATC with ATC, ATC with SAR, SAR with security, civil with military, aviation with maritime, and state with state.

In brief, some of the events that critically affected the SAR response were:

- A delay of more than 16 minutes after the aircraft's estimated time of arrival at the border before the loss of communication was reported by ATC;
- A delay of more than 38 minutes before an uncertainty phase was declared;
- A delay of 7 hours 21 minutes before an alert or distress phase was declared;
- A failure by the military to notify the RCC of radar data that showed an aircraft tracking west from the last reported position of Flight 370; and,
- A failure by two civil radar installations to notify the RCC of intermittent radar images that also indicated an aircraft tracking west across Malaysia.

An entire week was lost in a futile search of the South China Sea while the SAR system remained uninformed of highly indicative radar targets tracking farther west, to the Andaman Sea.

Such breakdowns in the transfer of information between military and civil sectors have occurred too frequently. While the need for the military to safeguard genuinely secure information is indisputable, it makes no sense for

A crewmember, above, on an Australian Department of Defence Lockheed AP-3C Orion joins a search for Malaysia Airlines Flight 370. Below, search and rescue officers of the Australian Maritime Safety Authority, working in the Rescue Coordination Centre in Canberra in 2014, coordinate the search.

Top: Australian Department of Defence; bottom: Australian Maritime Safety Authority information bearing on the immediate well-being of civilian airline passengers to be withheld as a matter of protocol.

Other concerns are that:

- The RCC operational decision-making process was interrupted by politicians;
- Cross-border search operations and use of military aircraft were severely hampered by a lack of regional SAR plans (although letters of agreement for cooperative response had been established);
- Allocation of search aircraft was mismanaged because of confusion about overlapping aviation and maritime SRRs in the South China Sea;
- Uncoordinated searches were conducted by separate authorities in different localities;
- Early offers of assistance from foreign states were refused;
- RCCs received some operational intelligence not from the greater air navigation system but from journalists and through diplomatic channels; and,
- ATC and SAR coordination overall was severely hampered by a lack of English language proficiency.[9,10]

SAR Shortcomings

It is fundamentally important that, in recounting these failures, blame should not be apportioned to individual operators, unless they are found wilfully negligent, or, necessarily, to the states involved.

Given the oft-repeated failures of these recent SAR actions, a critical question to be asked is whether the insufficiencies have been repeatedly local and unconnected or are more widespread and remain endemic in the global system.

Answers may be found in publicly available statistics.

ICAO SAR audits have found that:

- 43 percent of the world's states have no SAR legal framework, nominated SAR authority or organized resources;
- 46 percent of states have an insufficient SAR-skilled workforce;
- 40 percent have no SAR plan of formal arrangements to provide for civil/military cooperation; and,
- 36 percent have no formal arrangements for coordination between the aeronautical and maritime authorities.

Findings also indicate that:

- 40 percent of states have no arrangements to provide assistance to adjoining RCCs;
- 35 percent have no standing permission for entry of SAR units into foreign territory; and,
- 72 percent have no SAR staff proficient in the use of the English language.[11]

Global Flight Tracking

In the aftermath of these accidents, in March 2016, the ICAO Council adopted provisions — to take effect between now and 2021 — to:

- Require aircraft to carry autonomous distress tracking devices that can transmit location information at least once every minute in distress circumstances;
- Require aircraft to be equipped with a means to have flight recorder data recovered and made available in a timely manner; and,
- Extend the duration of cockpit voice recordings to 25 hours so that they cover all phases of flight for all types of operations.

Technology alone cannot be a panacea for overcoming all of the SAR system's shortcomings. The International Air Transport Association (IATA) has affirmed the need for other improvements. In a recent statement, IATA recalled that after the disappearance of Flight 447, "a series of recommendations were presented to ICAO to improve the ability to locate and retrieve FDRs [flight data recorders] when an aircraft is gone missing. IATA believes these efforts are still valid."[12]

The recommendations, from BEA, included a call for ICAO to "ensure that all states develop regional SAR plans or regional protocols covering all maritime and remote areas for which international SAR coordination is required" and to "encourage states to consider the establishment of joint (aviation/maritime) RCCs."

Both recommendations are directed toward the reorganization of SAR services to lessen the number of points of interface between services and states in the global system. Coordination of SAR services is key, and it is at points of interface that coordination is most prone to error. These points of interface must be reduced.

Global Organizational Solution

What is required is a worldwide network of consolidated regional RCCs serving amalgamated SAR regions that will have the appropriate capacity, expertise, reach and readiness of response to provide effective SAR services to passenger-carrying aircraft wherever they are flown and, particularly, across borders.

This arrangement need not supplant the existing 191 state RCCs and associated search areas. States have every right

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to establish RCCs within their sovereign territories to serve their domestic needs as they best determine. Indeed, this is their obligation under international law. There must, however, be an insistence that major SAR actions be made the responsibility of fully functional regional RCCs whose areas of jurisdiction will be determined on the basis of operational needs and service capacities. This is in contrast with an operational system that has, until now, been structured with undue regard to sovereign borders that have no operational relevance.

There is nothing drastic in this. ICAO, for decades, has observed that "in many areas of the world, the fastest, most effective and practical way to achieve a global SAR service is to develop regional systems."[13]

Some air navigation services have already adopted regional organization, including regional safety oversight organizations, upper airspace ATC, accident investigation and flight operations inspection.

The establishment of regional aviation RCCs for major SAR actions will extend coverage of effective SAR to all states through implementation of regional SAR plans for cross-border use of shared resources, assets, expertise and costs. It will standardize SAR services globally at ICAO-compliant levels, integrate all participating sectors, including military, maritime, security and police, and greatly reduce hazardous points of operational interface in the SAR system. It will leave no global gaps and will strengthen SAR to the point that it can, at last, be properly described as the safety net of last resort.

It is now vital and urgent that, at its highest levels, the aviation industry acknowledges the reality of SAR's global ineffectiveness and the need for it to be radically improved. In doing so, the industry must admit to the reality of the states' lack of capacity to fix it and commit to leadership for its reconstruction.

Brian Day was technical officer (SAR) at ICAO headquarters for seven years. His comments are based upon the provisions of Annex 12, Search and Rescue, to the Convention on International Civil Aviation. The author's opinions should be understood, in no way, to apportion blame but to assist in strategizing improvements to the global aviation SAR system. Day currently is an instructor and consultant worldwide and may be contacted at <brianday@brianday.aero>.

The opinions expressed in this article are those of the author and not necessarily those of Flight Safety Foundation.

Notes

1. Emergencies may be notified by various other means, including electronically through the Cospas-Sarsat satellite system.
2. An FIR is a defined region of airspace that has a flight information service and an alerting service.
3. BEA. *Final Report on the Accident on 1st June 2009 to the Airbus A330-203, Registered F-CZCP, Operated by Air France, Flight AF 447, Rio de Janeiro–Paris. July 2012.* Available at <www.bea.aero>.
4. SAR coordinators must measure the time required for suitably equipped rescue craft to arrive on-scene against the time period for which personnel may survive exposure in the open sea. While some fit and uninjured survivors have survived for prolonged periods, those who are elderly, injured or physiologically in shock cannot be expected to hold out for longer than 30 minutes. To take 10 hours to initiate a SAR action on the high seas does not begin to answer the urgency of survival. <bit.ly/1L9uLvf>.
5. The word *regional* is used in this article in its generic sense, not in reference to ICAO's seven designated regions.
6. GCAA. AAIS Case Reference 13/2010, *Uncontained Cargo Fire Leading to Loss of Control Inflight and Uncontrolled Descent Into Terrain — Boeing 747-44AF, N571UP; Dubai, United Arab Emirates; 03 September 2010.* English version, published July 24, 2013. Available at <gcaa.gov.ae/en>.
7. An SRR is a defined area associated with an RCC within which SAR services are provided by a state.
8. Debris has been found, but a search continues for most of the wreckage, including the airplane's flight recorders.
9. CNN. *Documents: Preliminary Report on Missing Malaysia Airlines Flight 370*. May 1, 2014. <cnn.it/1rTWcNP>.
10. ICAO. *ICAO Brief on the SAR Response to MH370.* Jan. 25–29, 2015. <bit.ly/1CyyQTW>.
11. ICAO. *Safety Audit Information*. <icao.int/safety/Pages/USOAP-Results.aspx>.
12. IATA. *Aircraft Tracking Task Force Frequently Asked Questions*. <www.iata.org/pressroom>.
13. ICAO; International Maritime Organization. *International Aeronautical and Maritime SAR (IAMSAR) Manual*, Chapter 1, Paragraph 1.6.2.

LACK OF Restraint

The 747 freighter was doomed when a massive military vehicle broke free in the cargo hold.

BY MARK LACAGNINA

The weight shift alone did not cause the flight crew to lose control of the Boeing 747 freighter when a military vehicle being carried as cargo tore free of its tie-down straps in the aft cargo hold on initial climb from Bagram Air Base in Afghanistan.

The airplane actually was rendered uncontrollable when the unrestrained vehicle smashed through the aft pressure bulkhead and destroyed components of the hydraulic systems and horizontal stabilizer drive.

The 747 pitched up, stalled, rolled into a rapid descent and exploded when it struck the ground in a nose-down and nearly wings-level attitude. All seven crewmembers were killed in the crash, which was captured on the dashboard-mounted video camera of a vehicle travelling nearby.

The U.S. National Transportation Safety Board (NTSB) investigation of the April 29, 2013, accident concluded that the probable cause was the air cargo airline's "inadequate procedures for restraining special cargo loads, which resulted in the loadmaster's improper restraint of the cargo."

In its final report, NTSB said a factor that contributed to the accident was inadequate

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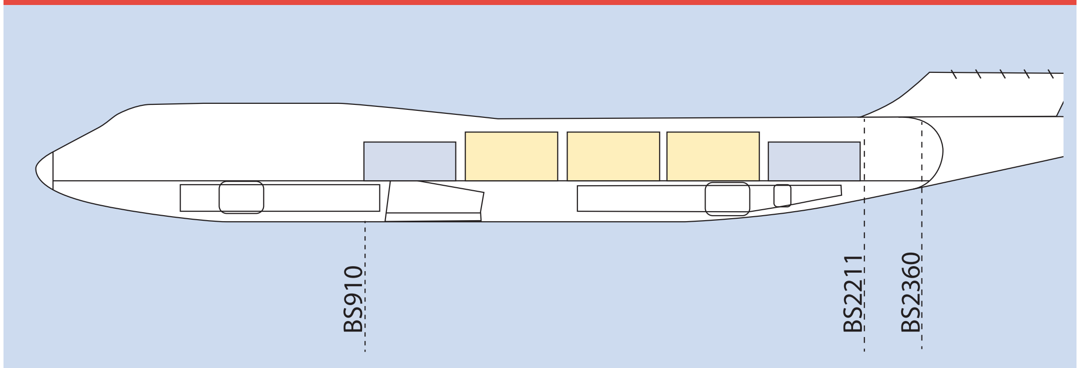
Load Positions of the Five Vehicles



Note: The 12-ton military vehicles (blue) were loaded forward and aft of the three 18-ton behicles (yellow). The vehicle near BS (Body Station) 2211 broke free.

Source: U.S. National Transportation Safety Board

Figure 1

oversight of the operator, National Airlines, by the U.S. Federal Aviation Administration (FAA).

The investigation revealed that the vehicle that broke free of its restraints was one of five that National Airlines, a civilian cargo company working under contract to the U.S. Department of Defense (DoD), had attempted to transport on the flight, despite manufacturers' guidance that they should be carried only one at a time.

'Special Cargo Load'

The supplemental cargo flight had begun in Châteauroux, France. The freighter was flown from Châteauroux to Camp Bastion, Afghanistan, where 207,500 lb (94,122 kg) of cargo was loaded. The flight then continued to Bagram to refuel. The ultimate destination was Dubai, United Arab Emirates.

Among the cargo loaded at Camp Bastion were five "mine-resistant ambush-protected vehicles" (MRAPs). The vehicle that broke free weighed 24,000 lb (12 tons, or 10,886 kg) and was loaded in the aft section of the main cargo deck, behind three 36,000-lb (18-ton, or 16,330-kg) MRAPs and another 12-ton vehicle (Figure 1). All of the vehicles were loaded facing forward.

"These vehicles were considered a 'special cargo load' because they could not be placed in unit load devices (ULDs) and restrained in the airplane using the locking capabilities of the airplane's main deck cargo handling system," the report said.

The investigation revealed that National Airlines did not have adequate procedures for securing special cargo loads and that neither the loadmaster assigned to the flight nor the pilots had previously transported heavy-vehicle special cargo.

Under the loadmaster's direction, the MRAPs were chained to floating pallets and lashed to the center of the main cargo hold with tie-down straps. Each of the smaller vehicles was secured with 24 tie-down straps, the larger vehicles with 26 straps. Each strap was rated at 5,000 lb (2,268 kg).

This did not comply with the operator's loading procedures, which indicated that 46 tie-down straps should be used for the 18-ton vehicles and 32 for the 12-ton vehicles. This is a moot point, however, because investigators found that National Airlines' loading procedures, themselves, were inadequate and that its cargo operations manual did not contain safety-critical loading information provided by the airplane manufacturer and the manufacturer of the main deck cargo handling system.

The airline's cargo operations manual "contained incorrect and unsafe methods for restraining cargo that cannot be contained in ULDs," the report said. "The procedures did not correctly specify which components in the cargo system (such as available seat tracks) were available for use as tie-down attach points, did not define individual tie-down allowable loads and did not describe the effect of measured strap angle on the capability of the attach fittings."

National Airlines' chief loadmaster had developed the loading procedures "without any coordination with the flight operations or safety personnel," and had developed a loadmaster training course without coordination with the airline's director of training.

"Had the chief loadmaster consulted the required manufacturers' weight and balance manuals, he could have determined that the intended load of five vehicles could not be properly secured in the airplane," the report said. "At most, only one [MRAP] could be transported."

New to MRAPs

The captain of the 747-400BCF (Boeing Converted Freighter) was 34 and had about 6,000 flight hours, including 440 hours as pilot-in-command (PIC) of 747-400s. He was employed by National Airlines in 2004. He initially flew as a Douglas DC-8 captain and upgraded to the 747 in 2012.

"The National Airlines check airman who gave the captain his most recent proficiency check described him as well prepared, dedicated and excellent in his training," the report said.

The first officer, 33, had 1,100 flight hours, including 451 hours as PIC and 209 hours as second-in-command of 747-400s. He joined National Airlines in 2009 as a DC-8 first officer and upgraded to the 747-400 in 2012.

"Two National Airlines captains who had flown with the first officer stated that his monitoring skills were great and that he had good flying skills for his low pilot time," the report said.

The loadmaster, 36, worked as a ground-handling supervisor and trainer for a trucking company before being hired by National Airlines in 2010.

The report noted that neither the pilots nor the loadmaster had any previous experience in transporting MRAPs. "National Airlines did not provide the accident loadmaster any special tie-down instructions or strapping plans for securing the MRAP vehicles on the main deck of the accident airplane," the report said.

The airline attempted to transport five of the massive military vehicles, despite the manufacturers' specified limit of one.

Sarah Lipfird | U.S. National Transportation Safety Board

'You Call, We Haul'

National Airlines, based in Orlando, Florida, U.S., was a subsidiary of National Air Cargo, based in Dubai. The airline operated three 747-400 freighters and one 757 passenger airplane. All of the 747s were flown overseas in support of DoD contract missions. The accident aircraft was a 747-400 that had been converted from passenger to freighter configuration in accordance with FAA-approved Boeing Service Bulletin 747-00-2004.

Although National Airlines previously had transported vehicles similar to MRAPs — with three aboard on one flight — it had not conducted a risk analysis of carrying heavy vehicle special loads on centerline-loaded floating pallets.

"The airline's safety department was not involved in the decision to begin carrying heavy vehicle special cargo loads," the report said. "When interviewed by investigators, the National Airlines chief loadmaster described the operator's role as 'you call, we haul.'"

The investigation found that the FAA principal operations inspector (POI) assigned to National Airlines did not detect the deficiencies in the airline's cargo operations manual and did not conduct a risk analysis when he learned in early 2013 that the airline was carrying heavy loads on pallets.

'They Always Move'

After the 747 was landed in Bagram, it was refueled, but no additional cargo was loaded.

The airplane was on the ground for about 90 minutes. Sporadic comments captured by the cockpit voice recorder (CVR) during this time indicated the crew discovered that some of the MRAPs had moved during the flight from Camp Bastion.

The first officer told the captain that one tie-down strap had broken and that all of the straps installed to keep the MRAPs from moving aft in the hold were loose.

According to the investigation's transcript of the CVR recording, the captain said, "I hope instead of just replacing that strap, I hope [the loadmaster is] beefing the straps up more."

"He's cinching them all down," the first officer said.

The loadmaster later came to the flight deck and was asked by the captain how far the vehicles had moved. "They just moved a couple inches because, you know, it's nylon," the loadmaster said.

"That's scary," the captain said. "Without a lock for those big heavy things … I don't like that. … Those things are so heavy, you'd think though that they probably wouldn't hardly move no matter what."

"They always move," the loadmaster said. "Everything moves. If it's not strapped."

The report said that although some of the discussion recorded by the CVR was conducted in a "joking manner," the comments indicated that the flight crewmembers were concerned that the cargo had moved and that they were relying on the loadmaster to know how to correct the problem and safely restrain the cargo.

Although the captain was ultimately responsible for ensuring that the cargo was loaded and restrained properly, neither pilot inspected the cargo before initiating the takeoff from Runway 03 at 1525 local time.

Thirty-Second Flight

Investigators determined that the tie-down straps on the aft vehicle failed when the airplane was rotated for takeoff. The unrestrained MRAP moved aft, struck the equipment rack on which the CVR and flight data recorder were installed, penetrated the aft bulkhead and disabled the no. 1 and no. 2 hydraulic systems, and the horizontal stabilizer jackscrew. The CVR and flight data recordings ceased at this time.

The airplane was 33 ft above the runway when it pitched nose-up and entered a steep climb. It then rolled right and descended rapidly until it struck the ground about 590 ft (180 m) from the departure threshold of the runway. The impact occurred 30 seconds after the freighter lifted off the runway.

"The airplane's steep pitch attitude and subsequent departure from controlled flight were consistent with an aerodynamic stall," the report said.

The captain, first officer, loadmaster, two pilots assigned to augment the flight crew, and two mechanics were killed. The 747 was destroyed by the impact and post-impact fire.

Debris found on Runway 03 included fragments of the airplane's fuselage skin, a segment of tubing from the no. 2 hydraulic system, a piece of the rack that holds the CVR and flight data recorder, and part of an MRAP antenna.

No Certification Standards

The report noted that the FAA does not require certification of cargo-handling personnel. "Thus, there are no standardized procedures, training and duty hour limitations and rest requirements for personnel who perform the safety-critical functions of loading and securing cargo," the report said.

The investigation revealed that the loadmaster had been on duty about 21 hours when the accident occurred. However, fatigue was not considered a factor. "Because the procedures and training for the accident loadmaster were so deficient, there is no evidence to suggest that enhanced rest opportunities for the loadmaster could have prevented the accident," the report said.

Nevertheless, the NTSB recommended that the FAA develop certification standards and duty/rest time requirements for personnel responsible for loading and documenting special cargo loads in transport category airplanes.

The safety board also recommended that the FAA improve procedural guidance for cargo operators and for inspectors overseeing cargo operations.

The report noted that "after the accident, the FAA, National Airlines and the National Air Carrier Association took numerous actions to enhance safety both at National Airlines and across the cargo industry.

"Many of these actions are ongoing and directly address operator procedures for, FAA oversight of, and industry knowledge about the proper restraint and aircraft limitation considerations for securing heavy vehicle special cargo loads."

This article is based on U.S. National Transportation Safety Board Aircraft Accident Report NTSB/AAR-15/01, "Steep Climb and Uncontrolled Descent During Takeoff; National Air Cargo, Inc., dba National Airlines; Boeing 747 400 BCF, N949CA; Bagram, Afghanistan; April 29, 2013."

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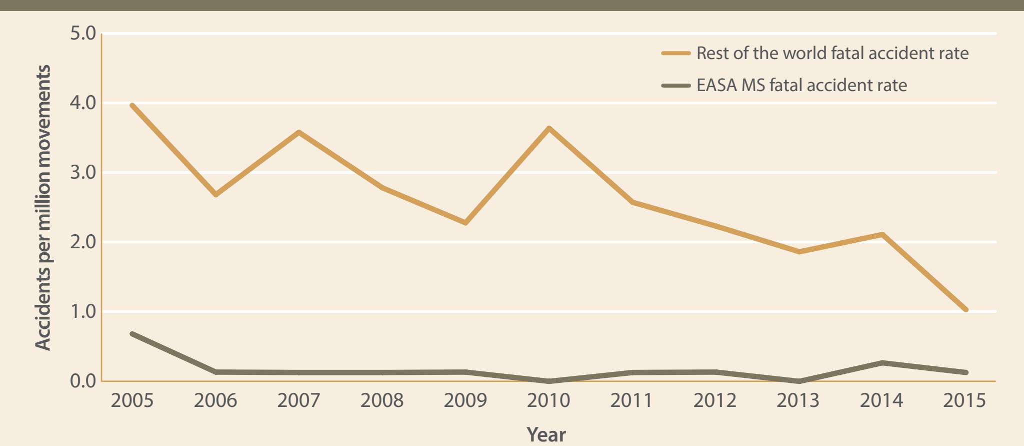
EASA Outlines Key Safety Risks

BY FRANK JACKMAN

European Aviation Safety Agency (EASA) member state (MS) operators of commercial air transport (CAT) airplanes of more than 5,700 kg (12,566 lb) maximum takeoff mass suffered one fatal accident in 2015, 24 nonfatal accidents and 58 serious incidents, according to EASA's *Annual Safety Review 2016*, released July 1. The one fatal accident was the crash of Germanwings Flight 9525 on March 24, 2015, in which 150 passengers and crew were killed. The crash is not universally included in aviation industry accident calculations because investigators determined that the crash was due to "the deliberate and planned action of the copilot, who decided to commit suicide while alone in the cockpit" (*ASW*, 5/16, p. 12). The International Air Transport Association, for example, did not include the Germanwings crash in its 2015 accident statistics (*ASW*, 3/16, p. 47).

In 2014, there were two fatal commercial air transport accidents among EASA MS operators, which continued a trend of no more than two fatal commercial accidents in any year since 2005, EASA said. For the 10-year period 2005–2014, the average number of fatal accidents among EASA MS airlines or air operator certificate holders was 1.3 per year, according to the EASA report. The average number of nonfatal accidents over the same period was 21.8 per year, and the average number of serious incidents was 75.8 per year. The 150 fatalities suffered in the Germanwings crash are more than double the

EASA MS Fatal Accident Rates, 2005–2015*



EASA MS = European Aviation Safety Agency member state

*In commercial passenger and cargo operations in aircraft with a maximum takeoff mass of more than 5,700 kg (12,566 lb)

Source: European Aviation Safety Agency

Figure 1

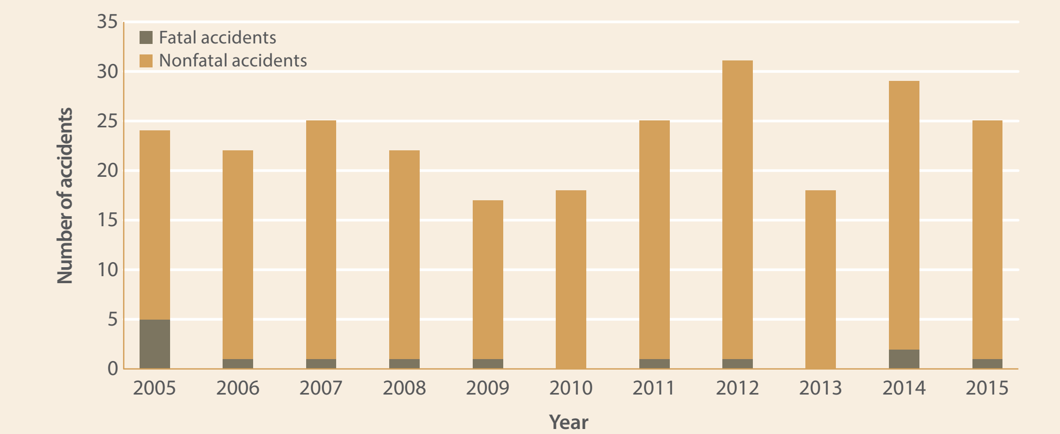
10-year average of 64.2 per year. EASA MS certificate holders had a lower rate of fatal accidents per million movements than did operators in the rest of the world (Figure 1).

During the 2005–2015 period, the number of accidents per year varied from a low of 17 (including one fatal accident) in 2009 to a high of 31 accidents (including one fatal) in 2012. There were 29 total accidents (including two fatal) in 2014 (Figure 2).

According to EASA's analysis of commercial air transport safety data, the "majority of accidents and serious incidents are still taking place during the en-route phase" followed by the takeoff, approach and landing phases. While the combined number of accidents and serious incidents in 2015 declined from the average for the 2005–2014 period, the number of accidents in 2015 was greater than the average for the 10-year period (Figure 3).

The EASA report identifies a number of key risk areas for CAT airplanes based on an analysis of historical occurrence data and the judgement of a variety of experts from EASA, member states and industry. Aircraft upset in flight (loss of control) is labeled as Key Risk Area 1. According to EASA, 64 percent of fatal accident outcomes involve aircraft upset in flight or loss of control, and loss of control has been the most frequent fatal accident type during the past year 10 years. This risk area also includes events that have been identified as direct precursors to loss-of-control events, including deviation from flight path, abnormal airspeed or triggering of stall protections.

EASA MS Fatal and Non-Fatal Accidents, 2005–2015*



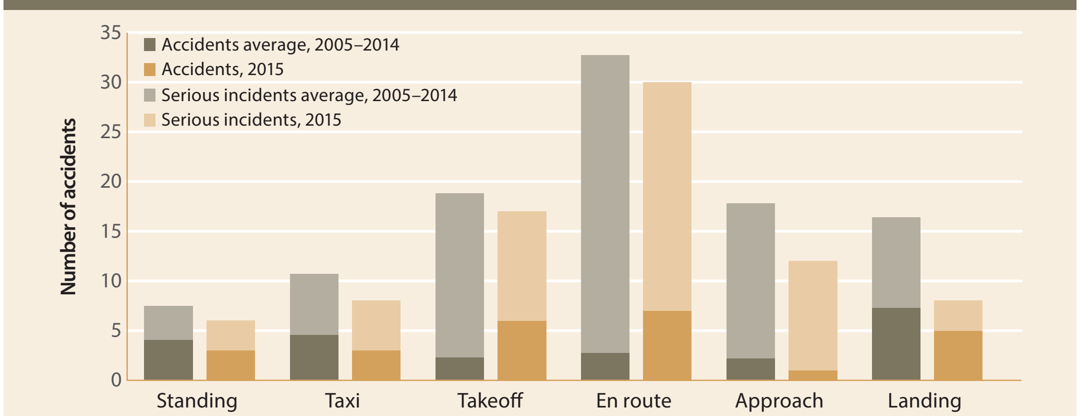
EASA MS = European Aviation Safety Agency member state

*In commercial passenger and cargo operations in aircraft with a maximum takeoff mass of more than 5,700 kg (12,566 lb)

Source: European Aviation Safety Agency

Figure 2

EASA MS Accidents and Incidents by Phase of Flight, 2005–2015*



EASA MS = European Aviation Safety Agency member state

*In commercial passenger and cargo operations in aircraft with a maximum takeoff mass of more than 5,700 kg (12,566 lb)

Source: European Aviation Safety Agency

Figure 3

The *Annual Safety Review 2016* also lists actions taken within or related to the European Plan for Aviation Safety (EPAS) to mitigate the key risk areas. EPAS actions for aircraft upset include a research project on startle effect management (*ASW,* 6/15, p. 16), a safety promotion on the new European provisions on pilot training, an action calling for member states to include loss of control–in flight in state safety programs (SSPs), and multiple rulemakings on loss-of-control prevention and recovery training, a rulemaking on loss of control or loss of flight path during go-around or climb, and rulemaking on unintended or inappropriate rudder usage, or rudder reversals.

Key Risk Area 2 is aircraft system failure. EASA said that with 45 percent of fatal accidents in the past 10 years involving technical failures, this represents both a major accident outcome and a precursor of other types of accidents. "Specific analysis work is ongoing to identify the systemic safety issues that may be present in the domains of airworthiness, maintenance and production," the report said. EPAS actions involving aircraft system failure include nine rulemakings on topics such as specific risk and standardized criteria for conducting airplane-level safety assessments of critical systems; the responsibilities of certified aircraft maintenance organizations and U.S. Federal Aviation Regulations Part 145 organizations; maintenance check flights; the airworthiness review process; tire pressure monitoring systems; and engine bird ingestion.

Ground collisions and ground handling, Key Risk Area 3, refers to the collision of an aircraft with other aircraft, obstacles or vehicles while the aircraft is moving on the ground, either under its own power or while being towed. It also includes all ground-handling related issues, such as aircraft loading and refueling. In the last 10 years, 27 percent of fatal accidents involved ground collision and other associated ground events, and there has been an increasing trend in this area, EASA said, adding that a dedicated analysis task will be carried out this year to "complete the identification of safety issues leading to this type of outcome." The EPAS actions for ground handling and ground collisions included two rulemakings (real weight and balance of an aircraft, and an analysis of the effect of on-ground wing contamination on takeoff performance degradation), two actions by member states (including ground safety in SSPs and erroneous weight or center of gravity) and a research project on the transport of lithium batteries by air.

Key Risk Area 4, terrain conflict or controlled flight into terrain, includes the controlled collision with terrain together with undershooting or overshooting of a runway during the approach and landing phases of flight, and comprises situations where an aircraft collides, or nearly collides, with terrain while the flight crew has control of the aircraft. It also includes occurrences that are the "direct precursors" of a fatal outcome, such as descending below instrument approach minimums or accepting a clearance below radar minimums issued by air traffic control. This risk area contributed to 18 percent of fatal accidents in the last 10 years, EASA said.

Key Risk Areas 5, 6, 7 and 8 are runway incursions, abnormal runway contact and excursions, airborne conflict, and fire, respectively. In the last 10 years, 18 percent of fatal accidents involving the EASA MS operators involved runway incursions, and detailed analysis of this area is planned for later in 2016. The abnormal runway contact and excursions risk area represents about 9 percent of the fatal accidents in the last 10 years. As far as the airborne conflict risk area is concerned, EASA noted that there have not been any CAT airplane collisions in recent years among EASA MS operators, but the risk area has been raised by a number of member states at the Network of Analysts, which was established in 2011 to provide a collaborative framework for EASA states to work together on safety analysis activities. The issue also has been raised by some airlines, "specifically in the context of the collision risk with aircraft without transponders in uncontrolled airspace," according to EASA.

Regarding the first key risk area, EASA said there have been no fatal accidents involving EASA MS operators in the last 10 years, but occurrences in other parts of the world make it an area of concern with the EPAS.

The *Annual Safety Review 2016* also outlines what EASA has determined to be the top safety priorities for CAT airplanes. The operational top safety issue is detection, recognition and recovery from flight path deviations during normal operations. For upset aircraft, this involves ability of the flight crew to identify potential loss of control situations and to take the correct recovery action. "In terms of the prevention of abnormal runway contact events and runway excursions, the risk assessment of this safety issue will look in more detail at landing scenarios involving unstabilized approaches. The *Annual Safety Review 2016* also outlines seven operational safety issues, three human factors safety issues and two organizational safety issues.

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'Flight Level Two Hundred'

Confusing clearance placed a business jet on a collision course with mountains.

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

Clarification Not Sought

BAe 125-800B. No damage. No injuries.

The Hawker flight crew was preparing for a trans-Atlantic flight with three passengers from Kerry Airport in County Kerry, Ireland, to Gander, Newfoundland, Canada, the afternoon of June 16, 2015. Their route clearance included a cruise altitude of Flight Level (FL) 340 (approximately 34,000 ft). However, as they lined up for departure on Runway 26, the airport traffic controller issued a departure clearance that included the instruction "stop climb flight level two hundred."

The pilots later would tell investigators for the Air Accident Investigation Unit of Ireland (AAIU) that they did not understand what "flight level two hundred" meant. However, they did not seek clarification from the controller, and their read-back of the instructions included the same phraseology, the AAIU report said.

Investigators concluded that the crew misinterpreted "flight level two hundred" as meaning 2,000 ft, rather than the controller's intention that it convey "flight level two zero zero" (approximately 20,000 ft).

Shortly after the Hawker took off, the Kerry airport traffic controller told the crew to establish radio communication with Shannon Low Level Control. After the crew left his frequency, the controller saw the aircraft level off at about 2,000 ft. He telephoned the Shannon facility and reported the situation to the planning controller.

The Shannon planning controller noted that the aircraft was tracking toward mountains rising to 2,800 ft and asked the airport controller if he could still see the aircraft. The controller replied, "He's just gone into cloud there."

The report said that the crew's confusion about their clearance showed when they established communication with the Shannon controller. They initially reported their altitude as "flight level two zero zero." The controller asked the crew to confirm their current altitude. The crew replied, "We were cleared only to flight level two zero zero."

The Shannon controller again asked the crew to report their current altitude. The reply was: "And we confirm that we are cleared up to flight level zero two zero … two thousand feet."

The controller immediately instructed the crew to climb to FL 300, cautioned them that they were nearing high ground and told them to "expedite your climb through four thousand feet."

The crew complied with the controller's instructions and subsequently completed the flight to Gander without further incident, the report said.

The AAIU concluded that the probable cause of the incident was that "the aircraft levelled at two thousand feet in close proximity to mountainous terrain, contrary to ATC [air traffic control] clearance."

The report said that contributing factors in the incident were that "the flight crew misinterpreted 'flight level two hundred' as two thousand feet" and that "clarification was not sought from ATC regarding the assigned stop climb flight level."

The nonstandard phraseology used by the airport traffic controller (i.e., "flight level two hundred" rather than "flight level two zero zero") was not deemed a factor in the incident.

"The phraseology used by the Kerry controller is that advocated by the U.K. CAA [Civil Aviation Authority] and some other European ATC agencies to minimise possible confusion when assigning a clearance to a flight level which ends in two zeroes," the report said.

Unexplained 'Health Problems'

Boeing 757-200. No damage. No injuries.

Investigators were unable to determine what caused cabin crewmembers aboard the 757 to experience "health problems" during a flight from Reykjavik, Iceland, to Frankfurt, Germany, the morning of July 18, 2012, said a report by the German Federal Bureau of Aircraft Accident Investigation.

The aircraft was cruising at FL 390 about one hour after takeoff when the purser told the pilot-in-command (PIC) that most of the cabin crewmembers experienced headaches, dizziness, sweating and other health problems while serving the passengers.

The flight crew saw no abnormal cabin pressure, air conditioning or other system indications. However, "in order to increase the fresh air supply in the cabin, the pilots shut off the right recirculation fan," the report said. "After the PIC discussed the situation with the maintenance control centre, the recirculation fan was switched on again and the flight was [continued at] a lower flight altitude."

The crew descended to FL 350 initially and then to FL 310, reducing cabin altitude to 7,000 ft and 4,000 ft respectively. "After the cabin crewmembers had been supplied with some oxygen either in the cockpit or the galley area, they felt much better," the report said.

However, when engine thrust was increased to level the 757 at FL 200 during the descent to Frankfurt, all seven cabin crewmembers experienced "strong symptoms such as dizziness, headaches, blue lips and fingers, and numbness in the legs," the report said.

The PIC requested and received priority handling from ATC for the approach and landing at Frankfurt. "After the landing the crewmembers sought medical treatment," the report said. "The PIC stated that the results of the medical examinations performed after the flight were all negative."

According to the aircraft manufacturer, previous cabin air problems in 757s had been attributed to airflow restrictions caused by foreign objects in the air conditioning system. However, examination of the incident aircraft revealed nothing that would have caused the reported health problems among the crewmembers, the report said.

Although all of the cabin crewmembers had suffered symptoms indicating oxygen deficiency, none of the passengers or pilots were affected. "One possible explanation could be the increased oxygen demand of the cabin crew due to them moving around the cabin, whereas passengers and flight crew were seated," the report said.

Misaligned Nosewheels

Gulfstream G-IV. Destroyed. Three fatalities.

En route on a positioning flight from Nice, France, the flight crew neglected to arm the ground spoilers during a visual approach to Le Castellet Aerodrome the afternoon of July 13, 2012. Failure of the spoilers to automatically extend resulted in delayed deployment of the thrust reversers and slow deceleration after touchdown.

A nose-up control input by the copilot, the pilot flying, then caused the nose landing gear to rise. "The crew responded by applying a strong nose-down input in order to make sure that the aeroplane stayed in contact with the ground, resulting in unusually high load for a brief moment on the nose gear," said the report by the French Bureau d'Enquêtes et d'Analyses.

The nose gear then deflected left, and the G-IV veered off the left side of the 1,750-m (5,742-ft) runway, traveled through a metal fence and struck trees. A fire erupted, and the sole firefighter on duty was unable to bring it under control. The cabin aid and both pilots were killed.

Investigators found that the nose gear had deflected beyond the limit that could be commanded by the rudder pedals. The report said that the deflection likely was caused either by input on the steering tiller or by a failure in the steering system.

"It was not possible to establish a formal link between the high load on the nose gear and this possible failure," the report said.

TURBOPROPS

Fire Erupts on Windshield

Bombardier DHC-8-202. Minor damage. No injuries.

The flight crew was conducting an approach in visual meteorological conditions (VMC) to Windsor Locks, Connecticut, U.S., the afternoon of June 5, 2015, when they heard a pop and saw electrical arcing near the windshield heat terminal block on the right side of the windshield.

A fire then erupted, and the pilots declared an emergency, donned their oxygen masks and told the cabin crew to prepare for an emergency evacuation, said the report by the U.S. National Transportation Safety Board (NTSB). The pilots twice attempted unsuccessfully to use fire extinguishers to suppress the fire, which eventually self-extinguished.

After landing, the pilots stopped the airplane on a taxiway, and all 37 occupants evacuated without injury.

"The arcing of the power wire produced enough localized heating to melt the glass and cause the fracture of the inner glass pane," the report said. However, thermal damage precluded a determination of what had caused the arcing.

The windshield had been on the Dash 8 since its manufacture 17 years previously. This "far exceeded the average life of 8.2 years reported by the windshield manufacturer," the report said. "The windshield exhibited typical signs of aging with ample evidence of moisture ingression into the laminate around the edges of the windshield," the report said.

However, "the aging discrepancies noted were within the published limits and did not contribute to the failure," the report said.

Investigators found the windshield heat selector in the normal position, in which electrical power would continue to be provided to the windshield heating system. "Switching the windshield heat selector to off would have cut power to the circuit, eliminating the arcing and fire," the report said.

The NTSB concluded that a contributing factor in the incident was the absence of guidance and training for flight crews on windshield electrical arcing, smoke, fire or overheating.

Survey Pod Cover Separates

De Havilland Twin Otter. Minor damage. No injuries.

The Twin Otter was equipped for geophysical survey flights and had electromagnetic sensor pods attached to both wing tips. During takeoff from Weston Airport in County Kildare, Ireland, the morning of Aug. 15, 2015, the nose cone on the right pod separated. This created a significant amount of right yaw, the AAIU report said.

The flight crew declared an urgency and diverted the flight to Dublin Airport, which had a longer runway and aircraft rescue and fire fighting services. The Twin Otter was landed in Dublin without further incident.

Investigators found that the nose cone had been removed from the pod during maintenance the previous day. "When the nose cone was being refitted during maintenance, the installation process was stopped for troubleshooting reasons, and consequently the reinstallation of all retention screws was not completed," the report said.

Flagging tape was not attached to the pod to show that the reinstallation of the nose cone had not been completed. Subsequent inspections of the pod by maintenance personnel, the copilot and the commander did not detect the missing fasteners.

Somatogravic Illusion

Cessna 208B. Destroyed. One fatality.

Night VMC prevailed on June 15, 2013, when the pilot landed the Caravan at Pellston, Michigan, U.S., to refuel and load cargo. "The pilot spoke with three employees of the fixed base operator, who stated that he seemed alert and awake but wanted to make a 'quick turn,'" the NTSB report said.

Almost immediately after the subsequent takeoff, the airplane entered a steep right turn, climbed about 260 ft and then descended into a heavily wooded area.

A post-accident simulation study "indicated that the load factor vectors, which were the forces felt by the pilot, could have produced a somatogravic illusion of a climb, even when the airplane was descending," the report said.

Because of "the degraded visual reference conditions … and the forces felt by the pilot, it is likely that he experienced spatial disorientation, which led to his inadvertent controlled descent into terrain."

Unconscious on Touchdown

Socata TBM 700. Substantial damage. No injuries.

The TBM 700 was en route from Gold Coast Airport in Queensland, Australia, to Lake Macquarie Airport in New South Wales on Dec. 15, 2015. "Having not previously landed at Lake Macquarie, the pilot overflew the aerodrome at approximately 1,500 ft above ground level to confirm the airfield layout," said the report by the Australian Transport Safety Bureau.

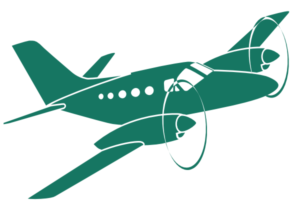
The single-turboprop was configured for landing, and the pilot flew the final approach at 80 kt. The pilot then began to feel "woozy" on short final approach and subsequently lost consciousness, the report said.

The aircraft bounced on touchdown and then struck the runway in a nose-low attitude. "It was at this time that the pilot regained consciousness, approximately 5 to 10 seconds after losing consciousness," the report said. "The aircraft then skidded on the runway before veering to the right and onto the grass."

Damage to the aircraft was substantial, but neither the pilot nor his passenger was injured.

"The pilot stated they were well rested, had eaten prior to and during flight, and were appropriately hydrated," the report said. "The pilot reported that they had no previous loss of consciousness events, nor were there any extra pressures or distractions that may have affected them during the flight.

"Medical tests and monitoring after the accident found that the loss of consciousness was due to a previously undiagnosed heart condition."



PISTON AIRPLANES

Low Altitude, Low Visibility

Piper Chieftain. Destroyed. Four fatalities.

The Chieftain departed with six hours of fuel from Samarinda, on the east coast of Borneo, Indonesia, at 0751 local time on Aug. 24, 2014, for an aerial survey flight at Bontang, also on the east coast of the island. The survey work was scheduled to be conducted 500 ft above the ground.

About an hour later, the pilot radioed that he was descending from 3,000 ft to 300 ft. Shortly thereafter, the company's flight-following system stopped receiving data from the aircraft.

The wreckage of the Chieftain was found two days later, 50 ft below the top of a ridge. "All occupants were fatally injured, and the aircraft was destroyed by impact force and post-impact fire," said the report by the National Transportation Safety Committee of Indonesia.

Dark clouds and rain had been observed in the area, and investigators found evidence that the Chieftain was in a climb when the impact occurred.

"The cloud cover [likely] prevented the pilot from being able to observe the terrain ahead of the aircraft," the report said. "This accident is typical of controlled flight into terrain. Low-altitude flying in a low-visibility environment limits the pilot's sight and increases the probability of impact with terrain."

Beyond the Limits

De Havilland Otter. Destroyed. Ten fatalities.

Before departing from the air taxi operator's base in Nikiski, Alaska, U.S., to pick up nine passengers in Soldotna the morning of July 7, 2013, the pilot loaded cargo estimated by the lodge operator to weigh 300 lb (136 kg).

"The cargo was not weighed, and the pilot did not document any weight and balance calculations, nor was he required to do so," the NTSB report said. Investigators later determined that the cargo actually weighed about 800 lb (363 kg).

The flight to Soldotna was completed without incident. After loading the passengers, whose estimated weight was 1,730 lb (785 kg), and 80 lb (36 kg) of baggage, the pilot initiated the flight to the lodge.

There were no witnesses to the takeoff. Investigators determined that the Otter stalled and struck terrain shortly after liftoff. All 10 occupants were killed, and the airplane was destroyed by the impact and extensive post-impact fire.

The investigation found that the Otter was within weight-and-balance limits during the flight from Nikiski to Soldotna but was slightly over maximum weight with a center-of-gravity 5.5 in (14.0 cm) aft of the aft limit during the subsequent departure.

The NTSB concluded that the probable cause of the accident was "the operator's failure to determine the actual cargo weight, leading to the loading and operation of the airplane outside the weight and center-of-gravity limits."

"Contributing to the accident was the Federal Aviation Administration's [FAA's] failure to require weight-and-balance documents for each flight in [Federal Aviation Regulations] Part 135 single-engine operations," the report said.

HELICOPTERS

Mast Bump Causes Break-Up

Robinson R66. Destroyed. One fatality.

The pilot had made five flights the morning of March 9, 2013, ferrying hunters and fishermen to and from remote sites in New Zealand's Kaweka and Kaimana mountain ranges. Wind velocity had increased as the day progressed, and the R66 encountered moderate turbulence over the Kaweka range during a positioning flight that afternoon.

Investigators for New Zealand's Transport Accident Investigation Commission (TAIC) determined that the turbulence was a factor when the helicopter experienced a severe "mast bump," in which the main rotor hub struck the rotor mast. A rotor blade then struck the fuselage, causing the helicopter to break up in flight.

Citing four other fatal R66 accidents resulting from mast bumps or low main rotor speed, the TAIC report noted that the FAA requires R22 and R44 pilots, but not R66 pilots, to complete special training to reduce the risk of such accidents.

"This was in spite of [the R66] having the same main rotor design and a similar response to low-G conditions as the R22 and R44," the report said.

Based on these findings, the TAIC recommended that the FAA require additional training for R66 pilots and that it "reinstate uncompleted research into the dynamic behaviour of lightweight helicopter main rotor systems."

"Until the behaviour of such rotor systems in conditions of low G and turbulence is fully understood, it is possible that not all of the causal factors of mast bump accidents will be identified," the report said. "There is insufficient industry knowledge of why Robinson helicopters are particularly vulnerable to catastrophic mast bump events."

Main Rotor Blade Disbonds

MD Helicopters 369D. Substantial damage. One serious injury.

The pilot was conducting an external-load operation over mountainous terrain in Oso, Washington, U.S., the morning of July 22, 2014, when one of the five main rotor blades separated. The helicopter then descended out of control, struck terrain and rolled down a hillside.

Investigators found that fatigue cracks near the root of the blade had caused the separation. "Further examination revealed that the fatigue cracks in the separated blade had initiated due to disbondment at the interface between the adhesive film on the blade subassembly and the upper and lower root fittings," the NTSB report said.

The board concluded that the pilot, who also held an airframe and powerplant mechanic's certificate and served as the helicopter's mechanic, had not properly performed inspections of the main rotor blades at the intervals prescribed in an airworthiness directive issued by the FAA to prevent root-fitting disbondment.

"Contributing to the accident was the lack of clear guidance in the helicopter maintenance inspection instructions, which allowed for the possible misinterpretation by maintenance personnel of their intent," the report said.

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Preliminary Reports, April–May 2016

Date	Location	Aircraft Type	Aircraft Damage	Injuries
April 1	San Ignacio, Durango, Mexico	Cessna 208B	destroyed	3 fatal, 5 serious
The Caravan was destroyed in a forced landing shortly after departing from Tayoltita for an air taxi flight.				
April 4	Jakarta, Indonesia	Boeing 737-800, ATR 42	substantial	56 none
The 737 was rolling for takeoff when its left wing struck the empennage and left wing of the ATR, which was being towed across the runway.				
April 4	Pigeon Forge, Tennessee, U.S.	Bell 206L	destroyed	5 fatalities
The helicopter struck a ridge shortly after departing from Sevierville for an air tour flight.				
April 6	Kanoya, Kagoshima, Japan	Raytheon U-125	destroyed	6 fatal
The aircraft, a military version of the Hawker 800, struck a mountain during a navaid calibration flight.				
April 7	Puerto Gaitán, Meta, Colombia	Douglas DC-3	destroyed	3 serious
The DC-3 was destroyed by fire during an emergency landing after an engine lost power on departure for a cargo flight.				
April 9	Taylor, Texas, U.S.	Rockwell 690B	destroyed	2 fatal
The airplane crashed out of control during an instructional flight.				
April 13	Kiunga, Papua New Guinea	Pilatus Britten-Norman Islander	destroyed	12 fatal
The Islander struck terrain 1.0 km (0.5 nm) from the runway on approach to Kiunga.				
April 19	Slidell, Louisiana, U.S.	Beech King Air A90	destroyed	2 fatal
Night visual meteorological conditions (VMC) prevailed when the King Air struck power line towers 0.6 nm (1.1 km) from the runway during a visual approach.				
April 20	Gander, Newfoundland, Canada	Beech 1900D	substantial	3 minor, 13 none
Low visibility and high surface winds prevailed when the nose landing gear collapsed on touchdown.				
April 24	Girona, Spain	Swearingen Merlin	substantial	2 NA
No fatalities were reported when the Merlin touched down with the landing gear retracted.				
April 26	Foley, Alabama, U.S.	Cessna 421B	destroyed	1 none
The 421 struck trees after an engine lost power on takeoff.				
April 28	Quito, Ecuador	Embraer 190-100	substantial	93 none
The flight crew apparently intentionally ground-looped the ERJ after overrunning the wet 1,900-m (6,234-ft) runway on landing.				
April 30	El Obeid, Sudan	Antonov 26	destroyed	5 fatal
The An-26 struck terrain 10 km (5 nm) from the airport during approach.				
May 3	Kamchatka Peninsula, Russia	Robinson R44	destroyed	3 fatal
The helicopter struck mountainous terrain during a flight from Khalaktyrka to Karymshina Volcano.				
May 4	Reedsville, Wisconsin, U.S.	MD Helicopters 369E	substantial	1 fatal
Surface winds were at 22 kt, gusting to 32 kt, when the helicopter struck terrain while maneuvering to perform power line maintenance.				
May 5	Juneau, Alaska, U.S.	Airbus AS350	substantial	1 serious
The pilot said that flat-light conditions prevailed when the air-taxi helicopter rolled over while landing on a snow-covered ice field.				
May 5	Manning, Alberta, Canada	Convair 580	substantial	2 minor
One pilot became incapacitated during descent for landing. The other pilot took control of the air tanker but lost directional control after touchdown. The 580 veered off the right side of the runway and struck a drainage ditch.				
May 5	Little Rock, Arkansas, U.S.	Cessna 310F	destroyed	1 fatal, 1 serious
The examiner was killed when the 310 struck terrain shortly after the left engine lost power on takeoff during an airline transport pilot check flight.				
May 6	Skagway, Alaska, U.S.	Airbus AS350	substantial	1 fatal
Marginal VMC prevailed when the helicopter struck snow-covered terrain about 4 nm (7 km) from the airport on approach.				
May 12	Acampo, California, U.S.	Cessna 208B	substantial	1 minor, 17 none
The pilot sustained minor injuries during a forced landing after the engine lost power on initial climb for a skydiving flight.				
May 18	Anderson Air Force Base, Guam	Boeing B-52	destroyed	7 none
The Stratofortress overran the runway during a rejected takeoff. The crew evacuated the bomber before it was destroyed by fire.				
May 19	Mediterranean Sea	Airbus A320-232	destroyed	66 fatal
All 56 passengers and 10 crewmembers are presumed to have been killed when the A320 struck the sea during a scheduled flight from Paris to Cairo.				
May 23	Texarkana, Arkansas, U.S.	Cessna Citation 501	substantial	1 none
The pilot apparently lost consciousness after the cabin depressurized at 43,000 ft. He regained consciousness after the Citation descended to 7,000 ft and then landed the airplane without further incident.				

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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