THE INVESTIGATOR

Air Accident Investigation Sector
UAE General Civil Aviation Authority

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الهيئـــة الــعـامـــة للطيـــران الـمـدنـــي
GENERAL CIVIL AVIATION AUTHORITY

Statement by
H.E. Saif Mohammed Al Suwaidi

Director General
General Civil Aviation Authority

On this occasion “The Investigator” is being published against a background of deep sadness because of the tragic accident that occurred at Rostov-on-Don on 19th March, 2016. On behalf of the staff of the General Civil Aviation Authority I offer our sincere condolences to the relatives of those who lost their lives in the accident.

At this difficult time for the bereaved families be assured that you are in our thoughts.

الهيئــة الـعـامـــة للطيـــران الـمـدنـــي
GENERAL CIVIL AVIATION AUTHORITY

Statement by
Eng. Ismaeil Al Hosani

Assistant Director General
Air Accident Investigation Sector

It is with profound sadness that I write these words. The worst event possible for our profession of air safety investigation has come to be. The accident that occurred at Rostov-on-Don took the lives of 62 people and inflicted enormous grief on their relatives and friends. The thoughts of all the personnel of the Air Accident Investigation Sector are with those affected by the terrible event of 19 March, 2016.

We are working diligently, as part of the international investigation team, to determine the cause of the accident, so that a similar tragic occurrence can be prevented from ever happening in the future.

Eng. Ismaeil Al Hosani

Assistant Director General
Air Accident Investigation Sector

Middle East and North Africa Society of Air Safety Investigators

2015 Annual Seminar and Workshops

The United Arab Emirates (UAE) General Civil Aviation Authority, Air Accident Investigation Sector, hosted the third annual Middle East and North Africa Society of Air Safety Investigators (MENASASI) Seminar on the 4th and 5th of November, 2015. The Seminar was held at the Intercontinental Hotel, Festival City, Dubai and was preceded by Workshops on Human Factors and Aviation Insurance.

The President of MENASASI, Ismaeil Al Hosani, opened the Seminar. He emphasized that the nature and complexity of air accident investigations required cooperation between the Investigating States and Industry Partners. He referred, in particular, to the absolute need for integrity, transparency, and professionalism in the investigation process. Ismaeil emphasized the benefits of MENASASI membership for accident investigators in the MID Region, and for the aviation industry as a whole, as the Society encourages and facilitates the sharing of knowledge, expertise, experience, training and specialized equipment.

The President of the International Society of Air Safety Investigators, Frank Del Gandio, informed the attendees of developments in ISASI and he commented on the excellent attendance of approximately 100 delegates and the exceptional venue for the 2015 MENASASI Seminar. Among the topics discussed during the Seminar were; Protection of Investigation Records; what lies ahead by Mr. Marcos Costa, Chief Air Accident Investigation, ICAO, Developing Investigative Capabilities by Captain Ibrahim Koshy, Director General, Aviation Investigation Bureau, KSA and North Sea Helicopter Accidents by Mr. Keith Conradi, Chief Inspector, UK Air Accidents Investigation Branch. Other topics presented included The Role of Aviation Psychology in Building a Culture of Safety by Dr. Edma Naddaf and Family Assistance – an essential element of accident response by Ms. Gill Sparrow representing Emirates Airline. The GCAA arranged for approved biohazard training to be provided to the attendees. Each attendee was provided with a biohazard training certificate which is valid for one year.

The 2016 MENASASI Seminar will take place outside the UAE for the first time. The event will be held in Rabat, Morocco, on 20 and 21 September. The invitation to hold the Seminar in Morocco was generously extended by Mr. M'Barek Lfakir, Head of AAIB, General Directorate of Civil Aviation.

2015 MENASASI Seminar attendees

Khalid Al Raisi

Director GCAA-AAIS

Desert Fort 03 Exercise

The Air Accident Investigation Sector (AAIS), as part of the 2015 GCAA Operational Plan, held an accident simulation exercise on 4th and 5th October 2015. The exercise was the third held to test the Sectors' operational readiness, and was This exercise was called Exercise 'Desert Fort 03' and took place at Liwa, Abu Dhabi. The location of the actual "accident site" was some 3 kilometres off-road in the desert.

Participating in the exercise were staff of AAIS and Falcon Air Services (FAS). The quad drone UAV suppliers Monster Middle East assisted with training on the new AAIS acquisition - a 3DR Solo, fully automated camera drone.

Objectives of Desert Fort 03 included;

- Ability of AAIS personnel to reach the accident site in the desert.
- Confirm that all equipment functions correctly and is fit for purpose.
- Confirm the ability of Investigators to work in the prevailing weather conditions using available clothing, biohazard suit, equipment, and supplies.
- Operation of the Solo drone at the accident site, including photographic capability.

In addition, an MOU signed in February 2011 between Falcon Air Services and the GCAA was successfully tested, as FAS were able to activate their notification process, assign a mission helicopter, and dispatch the GCAA Duty Investigator to the accident site with the FAS Go Team.

Successful deployment of the quad drone UAV was tested in the 46°C desert heat by the AAIS Team. This included verification of image and video capture. The videos captured were featured during the Dubai GITEX, which took place from 18 to 24 October 2015, and at the MENASASI seminar which was held from 3 to 5 November 2015 at the Intercontinental Hotel, Dubai.

Together with the Assistant Director General, Air Accident Investigation Sector and Director AAIS, a post exercise review was conducted and an action plan was initiated concerning areas where improvements can be made.

AAIS investigators test bio-hazard PPE in extreme heat conditions during Exercise Desert Fort 03.

Exercise Desert Fort 03 was successfully conducted in difficult desert and weather conditions with daytime temperatures of 46°C, and 80% relative humidity. All the AAIS and FAS personnel involved not only benefitted from the exercise, but enjoyed the various investigation activities that were undertaken.

AAIS Investigation Team – Exercise Desert Fort 03-Liwa

Sue Warner - Bean

Owner/Principal
Sue Warner-Bean LLC

Stakeholder Coordination in Family Assistance: The Key to Resilience

In her excellent article "Family Assistance – Essential Element of Accident Response," (The Investigator Volume 1 Issue 5, October 2015) Gill Sparrow outlined the genesis of ICAO family assistance policy and the key requirements of aviation disaster family assistance programs. This article will further explore the value of family assistance; the fundamental concerns of families; and how to develop a coordinated, multi-stakeholder family assistance program.

What is the first question an organization should ask when developing an emergency response program?

Some might begin by asking what they are required to do, who will staff their teams, and how will responsibilities be assigned? Others might start by addressing preliminary questions about command, control and communication. All of these aspects are important, but there is another question that lies further upstream, one that should inform all that follows. It is this:

How do you want your organization to be perceived in the aftermath of an aviation accident?

An aircraft accident is global news. Key players – especially investigators, airlines, and airports – will be in the spotlight almost instantly and will be the focus of public interest and scrutiny. Imagine reading a description of the accident response one week, one month, or one year after the event. What would you want to see? That your organization was compliant? Efficient? Effective? Or is there something more?

The duration and tone of public scrutiny will be determined in part by the nature of the accident: for example, Germanwings flight 9525 and Malaysia Airlines flight 370 remain in the public eye even today due to the sensational nature of both events. But another key factor will strongly influence perception, and that is the **treatment of families and friends of those onboard the aircraft.** If your organization is described with words

Source: U.S. National Transportation Safety Board

like transparent, responsive, compassionate, you are much more likely also to be described with one of the most crucial words of all: **resilient.**

Knowing what you want to achieve will help you chart your course: defining the outcome at the outset will shape and inform program development. With the goal of resiliency, the next step is to understand the concerns of family members in order to know how best – and who best – to meet them.

Fundamental Concerns of Family Members

The Office of Transportation Disaster Assistance (TDA), a small department within the U.S. National Transportation Safety Board (NTSB), was formed as a result of the Aviation Disaster Family Assistance Act of 1996. After two decades of responding to fatal aviation accidents, TDA staff have identified four fundamental concerns of families – issues and questions that arise consistently and repeatedly. In my work as an airline emergency manager and now as a consultant and trainer worldwide, I have found that these concerns are universal and transcend cultural differences. They are:

1. Initial notification of involvement
2. Victim accounting
3. Access to resources and information
4. Personal effects

No one agency or airline can address all of these needs on their own. Effective family assistance requires a coordinated effort between responding organizations.

Initial notification of involvement refers to the first contact with families informing them that something has occurred and their loved one is believed to be involved. This function falls to the airline because they maintain the passenger and crew manifest. Notification of involvement is typically done via a telephone enquiry center to maintain privacy of the manifest, ensure accuracy of information, arrange for data collection, and because families may be geographically widespread. If families are already gathered at airports, privacy, accuracy and data-collection still need to be taken into account. If airline staff numbers are limited, support from airport authorities, ground handlers, and other airline partners (alliances, marketing partners, or those with mutual aid agreements) may be required.

Victim accounting addresses families' need to know the location and condition of their loved ones. For surviving passengers, families will typically want to be reunited as soon as possible; for those fatally injured, families will be concerned with victim identification and the return and/or disposition of remains. Multiple organizations are involved in meeting these needs, including first responders, hospitals, medical or forensic authorities, airports, and airlines, or their handling agents. It is essential to establish processes for communication and data management in order to respond to families with urgency and accuracy.

Access to resources and information will also require thorough pre-planning and coordination. Families can be expected to travel to the accident location. Resources can and should be pre-identified to address all anticipated needs, from facilities, to security, to disaster mental health support. The affected airline will make logistical arrangements for their travel; while travelling, families' privacy and dignity must be respected through the cooperative efforts of airlines, airports, and Customs and Immigration.

Once families are at a Family Assistance Center (usually a hotel near the accident location), responding organizations will need to coordinate to provide services and especially informational briefings. The rule of thumb for briefings is that each responding entity should speak to its own area of expertise: search and recovery authorities will address crash site efforts; investigative authorities will speak about the investigative process and any relevant developments; medical or forensic authorities will discuss the victim identification process; airlines will explain what services they are providing; et cetera. And crucially, information should be provided to families before it is provided to the media.

Example of a Family Briefing Agenda

1. Introductions and opening remarks
2. Accident investigation process and status
3. Search and rescue / recovery status
4. Victim identification process
5. Personal effects recovery and return
6. Event information (site visit, memorial service)
7. Resources, services and support available on site
8. Questions
9. Closing – schedule for next meeting

Personal effects are items belonging to those onboard the aircraft (also to individuals who were not onboard the aircraft but were impacted by the accident). Accident survivors will want to reclaim their possessions; families will want to obtain the possessions of their deceased loved ones. Even seemingly insignificant items can be deeply important: a key, a photo, a book, or an item of clothing. Again, coordination between responding organizations is crucial to ensure these items are recovered from the crash site, released to the airline, or their contracted service provider, and returned to the appropriate family.

Stakeholder Coordination and Planning

In order to be perceived as responsive and effective in their handling of the aftermath of an accident, organizations must be prepared to address the fundamental concerns of families. And in order to address the fundamental concerns, they must be prepared to coordinate their efforts. Family assistance is not a solo enterprise; it is a multi-agency, multi-stakeholder endeavor. It requires collaboration, cooperation, and planning.

Dwight Eisenhower said “Plans are nothing; planning is everything.” Very often a plan is a document that sits on a shelf. Planning, on the other hand, engages stakeholders and lays the true groundwork for a response. Calls and emails are a good starting point, but face-to-face meetings provide the best opportunity to coordinate and forge critical relationships.

If there is a national aviation disaster family assistance law or policy, the designated government authority is best-positioned to bring stakeholders to the table; otherwise this is best done by the national investigative agency, airlines and airports. It can be useful to create a grid that documents primary and supporting roles for family assistance tasks in order to clearly define roles and responsibilities. The grid also illustrates the complexity and interconnections of the family assistance response.

Example of a Stakeholder Roles and Responsibilities Grid (not exhaustive; example only)

P = Primary Responsibility; S = Supporting Role

Agency / Functions	Airport	Airline (may utilize vendor or contracted service provider)	Investigative Authority	Fire and rescue; local emergency services	Police	Hospitals and/or Public Health	Disaster Mental Health Provider	Customs/Immigration	Medical Examiner / Coroner	Foreign Affairs Department
Verify passenger and crew manifest (Note: airline will keep this confidential)		P						S		
Establish secure private areas for relatives and friends to gather at airport	S	P			S		S	S		
Make initial notification of involvement to families	S	P								S
Provide arrangements for families to travel to the accident location	S	P						S		S
Victim/survivor accounting	S	P		S	S	S	S	S	S	S
Victim identification		S	S	S	S	S			P	S
Search and rescue / recovery			S	P	S	S				
Law enforcement and security services	S	S		S	P			S		
Establish a Family Assistance Center	S	P	S		S		S		S	
Return personal belongings	S	P	S	S	S	S			S	
Accident investigation	S	S	P	S	S	S		S	S	
Coordinate with governments of foreign citizens		S	S			S		S	S	P
Disaster Mental Health		S	S	S	S	S	P			
Childcare							P*			
Coordinate a memorial service							P*			

*Role required by law in the U.S.; will vary in other countries

Initial stakeholder meetings should focus on foundational topics. These typically include:

- clarifying family assistance principles and priorities
- defining roles and responsibilities
- establishing protocols for communication, command and control

As the groundwork becomes established meetings can expand to include case studies, guest speakers, trainings, and tabletop exercises. Stakeholder meetings should not be a "one-and-done" event; they should be held at regular intervals in order to cultivate relationships and increase responders' comfort level with responsibilities.

Shortly after the Aviation Disaster Family Assistance Act was passed in the U.S., I was tasked with designing and implementing my airline's family assistance program. Our plans were still very much a work in progress when our company had suffered a fatal accident; thankfully our planning was well underway, and it proved to be vitally important. Our strategy for planning included:

1. **Clarifying priorities.** There are an infinite number of variables in any accident scenario. It was impossible to write a checklist for every eventuality, but it was possible to set our priorities.

   - Care and welfare of families
   - Care and welfare of employees
   - Full cooperation with authorities
   - Professional responsiveness to media
   - Continuity of operations

Company-wide, we knew that the first priority was care and welfare of the affected families. That became the compass we used to navigate the chaos, and it was vital to our organization's resilience.

2. **Keeping leaders informed and engaged.** We met with executives, briefed them on requirements, best practices, roles of responding organizations and the company's capabilities. We reviewed good and bad case studies with them, emphasizing the impact on organizational reputation and the role of senior leadership. We briefed them on progress and brought in a family member from a past accident to share his personal experiences with them.

3. **Monthly team leader meetings.** Meetings included management representatives not just of family assistance functions, but of every group with a role in the company's emergency response plan – accident investigators, stations, corporate communications, finance, risk management, and others. Each department would give a progress report. We brought in guest speakers, carried out tabletop exercises and looked at case studies. The meetings served the dual purpose of education and mutual accountability. They had the added benefit of cultivating internal relationships. The meetings helped us to achieve an integrated and coordinated program – family assistance was not peripheral, or an adjunct; it was woven into the fabric of the emergency response plan.

4. **Developing key relationships.** Our team leader meetings cultivated internal partnerships, but external partnerships were equally important. We focused on seven vital relationships with those organizations we knew would respond to an accident, or whose help would be critical:

   - **The investigation authority (NTSB).** We made opportunities to visit their offices. We hosted them for a joint training session with the airline, airports, and first responders.
   - **Insurer.** We met with our underwriter and went through a list of potential family assistance costs, point by point.
   - **Vendors.** We knew we needed to outsource specific functions, particularly handling of personal effects. We chose a vendor, met with them, visited their operation, and discussed how we would coordinate during a response.
   - **Disaster mental health providers.** The Red Cross has a legislated role in family assistance in the US; we developed strategic partnerships at the national and local levels. We also retained a private company to provide disaster mental health services to our employees, and ensured that they were embedded in our response organization.
   - **Airports.** We knew that airports could be the first point of contact for many family members, and that our staff would likely be overwhelmed. We had every station manager identify facilities and resources in their city and partner with their airport emergency managers. In cities where airports held quarterly emergency response planning meetings, we encouraged local station participation.
   - **Other airlines.** Passengers' families can be from anywhere in the world. We laid the groundwork for mutual aid in the event families traveled on other airlines.
   - **Family member associations.** These proved especially critical in the year following the accident. Several family members from other accidents became our advisors in discussions about an anniversary commemoration and construction of a monument.

5. **Team member recruitment and training.** Finally, we recruited and trained family assistance team members and other responders.

Did these efforts make a difference? Yes. The response was not perfect, but families generally responded positively to the care that was provided. The company weathered other post-accident issues and challenges and today it continues to thrive.

Family assistance planning is a complex, multi-stakeholder endeavor; responding is even more so. Families, after all, do not have checklists; every event will have an almost infinite number of variables and will require adaptability, communication, and close coordination among responding organizations. Partnership and planning are essential.

In the face of disaster, will your organization be perceived as resilient? Family assistance can be the key.

Sue Warner-Bean

Owner/Principal, Sue Warner-Bean LLC Emergency Response Planning

Sue Warner-Bean is a consultant specializing in aviation emergency preparedness and response. She is an instructor for the University of Southern California's Aviation Safety and Security program (Accident and Incident Preparedness: Family Assistance). She has also written and delivered courses in family assistance and emergency planning for the Singapore Aviation Academy and the International Air Transport Association (IATA) Training and Development Institute.

Sue began consulting after a successful 20-year career with Seattle-based Alaska Airlines. She was the architect and director of the airline's Emergency Response Planning department, developing emergency response plans, training, procedures, facilities and exercises. She coordinated with company executives and U.S. NTSB officials following the crash of Flight 261 and continued to liaise with company officers, the family association, agencies, vendors and employees through all phases of the three-year response process.

As a consultant, Sue has developed emergency response plans, delivered family assistance training and conducted exercises for a wide range of clients including small corporate flight departments, business jet charter operators, cargo carriers, and major international airlines. She is also Principal Investigator for the U.S. Transportation Research Board's Airport Cooperative Research Program Project 06-03: Establishing a Coordinated Local Family Assistance Program for Airports.

Sue is an associate member of the International Society of Air Safety Investigators (ISASI), the International Aviation Women's Association (IAWA) and a former steering committee member for the IATA Emergency Response Planners Working Group. She resides in Seattle.

Alaska Airlines Flight 261 Memorial

Abdelati Al Fadil

Senior Air Accident Investigator
GCAA - AAIS

Interview with Marcus Costa Chief, Accident Investigation, ICAO

During the last MENASASI Seminar in Dubai, Abdelati Al Fadil, Senior Air Accident Investigator, took the opportunity to interview Marcus Costa, Chief Accident Investigation, ICAO. Abdelati enquired about Marcus' early career and his views on current and future air safety investigation topics. The most senior investigator provided interesting and thoughtful responses;

Q. Describe your career in aviation?

A. I started my aviation journey as a cadet with the Air Force Academy of Brazil in 1976, and graduated in the class of 1979. In 1982, I got my flight instructor's license and later on became a transport pilot. I initiated my safety career as a Flight Safety Officer in 1981, being involved with operational and maintenance related matters. In 1985, upon returning from the University of Southern California's Flight Safety Officers Course in the U.S., I joined the Brazilian Safety Centre (CENIPA), where I was a senior faculty member for 19 years, and held numerous positions including Chief, Research and Analysis Division, and chaired the working group that developed the national Confidential Safety Reporting System.

I was also a member of the Aviation Safety Committee of the Airlines' Union and a qualified civil aviation inspector. In 1994, I received my Master's degree in Aviation Safety from Central Missouri State University in the U.S. In 2000, I was designated Deputy Chief of CENIPA, and Chairman of the National Committee for Accident Prevention. Subsequently, I was appointed Chief of CENIPA from 2002 to 2004. I then decided on an early retirement from the Brazilian Air Force and joined the Airport Authority of Brazil (INFRAERO) as a safety adviser. In November 2004, I joined ICAO as Chief, Accident Investigation Section.

Q. Please give your views on Air Safety Investigations in the MID Region.

A. Different regions pose varying challenges for investigators. Hostile environments, such as jungle, the High Seas, and deserts require special training and adequate personal protective equipment for investigators to carry out their work. I am aware of periodic training held by AAIS in order to keep its investigators current with demands imposed by adverse conditions in the desert, which other accident investigation authorities of the region would be encouraged to follow suit.

Some other Mid Region States are obtaining significant progress in achieving the functional independence of their investigation authorities. For me, all of this is a clear indication of the professionalism and commitment towards safety in the Mid Region.

Marcus Costa and Abdelati Al Fadil

Q. What is your opinion of the value of MENASASI?

A. I extend my congratulations to this initiative by the UAE. The establishment of the Middle-East and North Africa Society of Air Safety Investigators - MENASASI, has proven to be the right avenue to foster cooperation and exchange of lessons and best practices within the regional aviation community, which will result in enhanced efficiency of investigations.

Topics and discussions held at MENASASI 2015 were insightful and attuned with current safety priorities. I was particularly impressed with the transparency of the debates, together with the level of expertise of the presenters and attendees. MENASASI 2015 was indeed a very successful event!

Q. What do you think are the most important challenges facing air safety investigations today?

A. The speed of communications in the era of social media is perhaps the biggest challenge that investigation authorities are facing nowadays, bringing along a fearsome aspect to investigations, i.e. inconsistency of information. The "social media era" has demanded that investigation progress reports are brought to the forefront and done expeditiously, literally on a daily basis. Investigators are trained to validate and corroborate any piece of information before making it public. Validation is commonly done even with the so called factual information, which sometimes may prove not to be so factual.

One can easily appreciate the challenges faced by investigation authorities in providing validated information to the media on a daily basis, and often times more frequently, especially when a major investigation is underway. I would emphatically recommend that those authorities put in place well-thought procedures to communicate with the media in the first few days following an accident. To this effect, all investigators are encouraged to consult the ICAO guidance on this subject.

Another major challenge for investigation authorities relates to the use of their reports for other than safety-related purposes, which may have an adverse effect on safety and jeopardize the availability of associated information in the future. States have long recognized such adverse impact on safety during ICAO meetings. As a consequence, much work has been done in the last few years resulting in the development of new provisions for the proper protection and use of accident and incident investigation records, to be incorporated into ICAO Annex 13 in 2016. And this was the theme of my presentation at the MENASASI 2015.

Q. If you could make one improvement in air safety investigations, what would it be?

A. This is certainly not an easy question, as such investigations are at the pinnacle of the industry's safety initiatives when comprehensiveness and transparency are considered. But I would offer one suggestion that would help safety investigations achieve optimal effectiveness and efficiency: accident investigation authorities need to be properly resourced with qualified investigators, adequately funded, and functionally independent from other aviation authorities and entities that could, to any degree, interfere with the goals and conduct of the investigations.

And allow me to recall that the only objective of an Annex 13-type investigation is the prevention of accidents and incidents, and not the apportioning of blame, or liability.

Q. Do you think that air safety investigation agencies are making enough progress in obtaining the knowledge and training necessary to build experience to investigate drone accidents?

A. Annex 13 was the first ICAO Annex to address Remotely Piloted Aircraft Systems (RPAS), attesting to the proactivity of the investigation community that first discussed RPAS issues at the 2008 AIG Divisional Meeting. Undoubtedly, investigations involving RPAS will pose new challenges, and much discussion is underway by the ICAO Accident Investigation Panel in order to accommodate this new aspect into investigation procedures and techniques.

Guidance material for investigating RPAS has been developed by ISASI and will be considered for incorporation into ICAO's manuals. It is acknowledged that most of the experience in investigations of RPAS is still limited to the military environment, and accident investigation authorities are encouraged to seek their cooperation through memoranda of understanding, and other similar arrangements.

Q. You have reached the highest position in air safety investigation. What would you like to achieve next?

A. I feel privileged to be occupying the chair of the Accident Investigation Section of ICAO, and to be able to facilitate the progress of global investigation provisions. But make no mistake, the heaviest burden of the safety arena rests on the shoulders of the accident investigation authorities who are the ultimate custodians of safety, going into action when all safety defences and barriers have failed. They are truly the ones holding the most distinct position in the air safety investigation domain. It has been an honour to represent the accident investigation authorities in ICAO.

As for the future, I would like to see palpable progress in cooperation of investigations among States with limited resources. In this regard, I am a firm believer that the best way forward would be the establishment of Regional Accident and Incident Investigation Organizations (RAIO). Some initiatives are in progress worldwide, with ICAO Regional Offices fostering RAIO discussions and developments when appropriate. Interested States are encouraged to refer to the ICAO Manual on Regional Accident and Incident Investigation Organization (Doc 9946) for further information and guidance.

Q. What do you like to do in your spare time? Do you have any pastimes?

A. I guess the passion for investigations led me to seek activities during my leisure time with similar challenges; it had to be a hobby requiring tenacity, perseverance and focus, just like a major investigation. Well, I found "golf" at a later stage of my life. I started playing this amazing game some five years ago and have turned myself into an avid weekend golfer… and I soon realized that hitting a small white ball in the sweet spot is far more challenging than I ever imagined!

Lithium batteries: Safe to fly?

Christine Bezard
Head of Human Factors & Ergonomics in design - Safety advisor
Airbus

Ian Goodwin
Director Flight Safety - Safety Enhancement
Airbus

Peimann Tofighi-Niaki
Flight Safety Enhancement - Flight Operations and Training Support
Airbus

Paul Rohrbach
Fire Protection - Project leader Lithium batteries as cargo
Airbus

Today, Lithium batteries play a barely visible, yet essential role in both our daily life and aviation alike. Manufactured and handled correctly, Lithium batteries are safe. But production failures, mishandling, or not being aware of their specific characteristics can have serious repercussions.

Lithium batteries are today's power source of choice. As we become ever more reliant on Portable Electronic Devices (PEDs) to provide at your fingertips, information, entertainment and communication, then so increases the demand for more powerful, yet lighter, sources of power.

Hundreds of millions of Lithium batteries or equipment with Lithium batteries are carried on aircraft annually. These can be as part of passengers carry-on items, as aircraft (e.g. Portable IFE, defibrillators) or aircrew equipment (such as Electronic Flight Bags). They can be shipped as cargo in battery form, or within other purchased items to support the demand for "just in time deliveries", or indeed as power supply for aircraft equipment. Lithium batteries are becoming continually more common place in the aircraft environment.

But the introduction of Lithium batteries included some highly visible cases of cell phones or laptops self-igniting and burning. Likewise, several events have occurred on aircraft, ranging from localized and limited fires to large, uncontrolled in-flight fires resulting in hull losses and fatalities.

The air industry has become more aware of the specific characteristics of Lithium batteries and the associated risks can now be mitigated. Procedures have been developed to address the risks for Lithium batteries being part of the aircraft design, those belonging to passenger or crew carry-on items, or indeed procedures linked to the shipping of Lithium batteries as cargo.

Lithium Batteries:

A powerful and versatile technology, associated with a common risk

Lithium is the metal with the lowest density, but with the greatest electrochemical potential and energy-to-weight ratio, meaning that is has excellent energy storage capacity. These large energy density and low weight characteristics make it an ideal material to act as a power source for any application where weight is an issue, aircraft applications being a natural candidate.

While the technology used and the intrinsic risk is the same for all applications, different solutions and procedures exist to mitigate this common risk depending on where and how the Lithium battery is used (i.e. part of the aircraft design, transported as cargo or in passenger and crew luggage and PED). This section will highlight the benefits of this new technology irrespective of its use in applications, and describe the associated risk of "thermal runaway".

Lithium: an increasing use

Experimentation with Lithium batteries began in 1912 and the first Lithium batteries were sold in the 1970's. In the nineties, Lithium battery technology began to be widely used by a number of industries that were looking for light, powerful and durable batteries.

As it turns out, Lithium use in batteries has been one of the major drivers of Lithium demand since the rechargeable Lithium-ion battery was invented in the early nineties (fig.1).

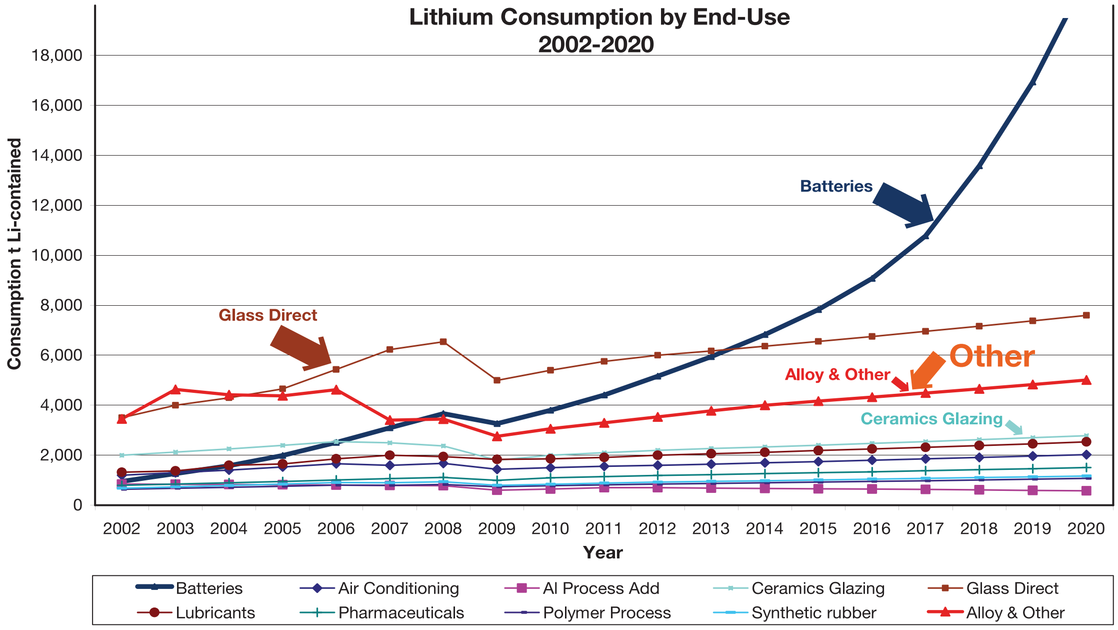


Figure 1: Forecast Lithium demand by application (Source: TRU Group)

Today, Lithium batteries are progressively replacing previous technology batteries – e.g. Nickel-Cadmium, Lead-acid – and can be found in most of electronic and autonomous electric systems or equipment. Development and applications are evolving with latest uses including ultrathin (down to 0.5 mm) and flexible technologies.

The Lithium battery market is extremely dynamic and expanding fast, with a growing application as the power source for a wide range of electric vehicles. In fact, no level off is foreseen in the coming years. In 2014, 5.5 billion Lithium-ion batteries were produced (fig.2).

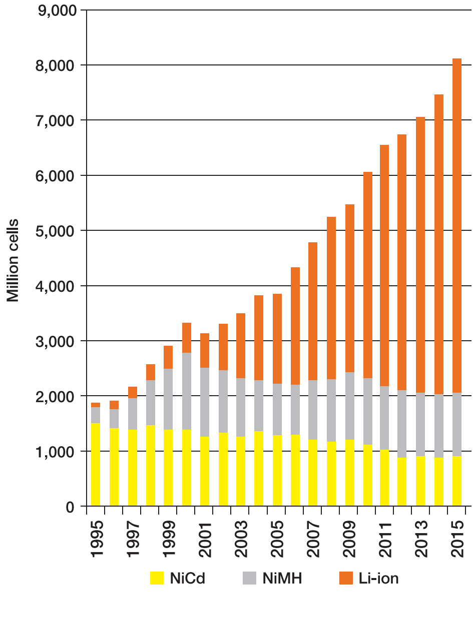


Figure 2: Worldwide batteries production (Source: Christophe PILLOT, Avicenne Energy)

Different types of Lithium batteries, different applications

Different types

Lithium batteries can take many forms. They can be as tiny as single cell button batteries - for example used as power supply for watches - or multi cells (usually rechargeable) batteries that can act as high power energy sources for electric vehicles, or indeed as back-up power supply on-board aircraft (fig.3).

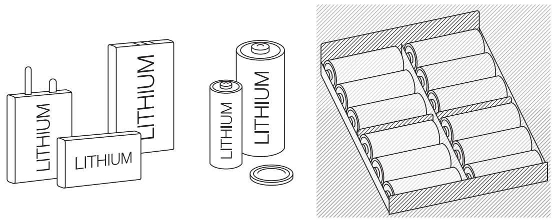


Figure 3: Types of Lithium batteries: single / multi cells

Different technologies

The term “Lithium battery” actually refers to a family of batteries that can be divided into two categories:

Primary: Lithium-metal, non-rechargeable batteries

These include coin or cylindrical batteries used in calculators, digital cameras and emergency (back-up) applications for example (fig.4).

Lithium-metal batteries have a higher specific energy compared to all other batteries, as well as low weight and a long shelf and operating life.

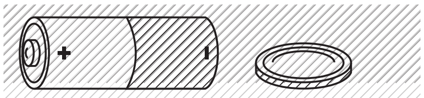


Figure 4: Lithium-metal batteries

Secondary: Lithium-ion / Lithium-polymer rechargeable batteries

Key current applications for this type of batteries are in powering cell phones, laptops or other hand held electronic devices, as well as electric/hybrid cars and power stores (fig.5).

The advantages of the Lithium-ion or Lithium-polymer battery are its ability to be recharged in addition to its higher energy density and lighter weight compared to nickel-cadmium and nickel-metal hybrid batteries.

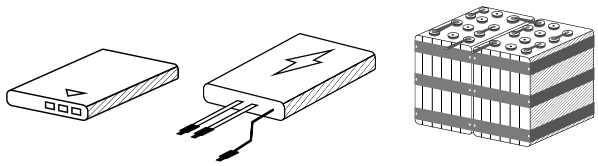


Figure 5: Lithium-ion / Lithium-polymer batteries

One main intrinsic risk to tackle: the thermal runaway

As with every new technology, Lithium batteries offer a number of advantages, but they also come with limitations. Although previous battery technologies were not risk free. Lithium based batteries have a larger electrochemical potential; therefore if damaged, mishandled or poorly manufactured, they can suffer stability issues and be subject to what is called a "thermal runaway". This phenomenon is well recognized now, and it can be mitigated providing awareness and prevention actions are taken.

A self-ignited and highly propagative phenomenon

In case of internal degradation or damage, a battery cell rapidly releases its stored energy (potential and chemical through a very energetic venting reaction, which in turn can generate smoke, flammable gas, heat (up to 600°C and 1000°C locally), fire, explosion, or a spray of flammable electrolyte. The amount of energy released is directly related to the electrochemical energy stored and the type of battery (chemic and design).

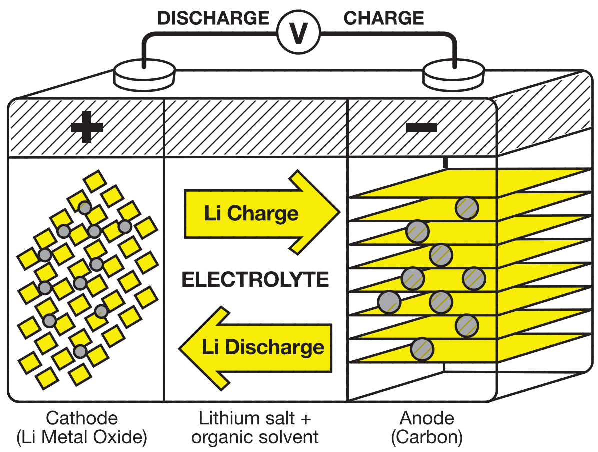
Both the primary and secondary types of batteries are capable of self-ignition and thermal runaway. And once this process is initiated, it can easily propagate because it generates sufficient heat to induce adjacent batteries into the same thermal runaway state.

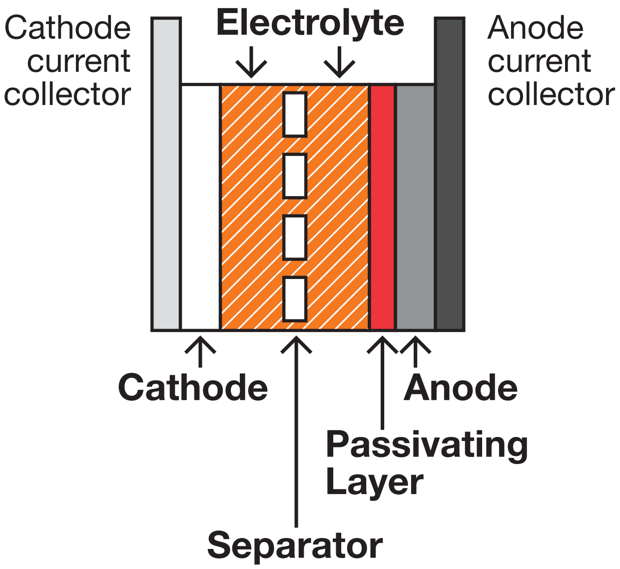
Lithium batteries can be both a source of fire through self-ignition and thermal runaway, and a cause of fire by igniting surrounding flamable material.

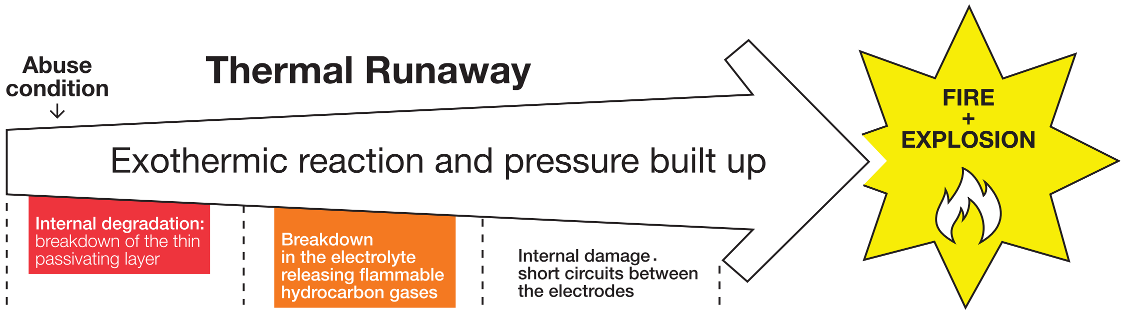
Insight Into The Thermal Runaway Phenomenon

A thermal runaway consists of an uncontrolled energy release. It refers to a situation where an increase in temperature changes the conditions in a way that causes a further increase in temperature, often leading to a destructive result.

In multi-cell batteries, the thermal runaway can then propagate to the remaining cells, potentially resulting in meltdown of the cell or a build-up of internal battery pressure resulting in an explosion or uncontrolled fire in the battery.

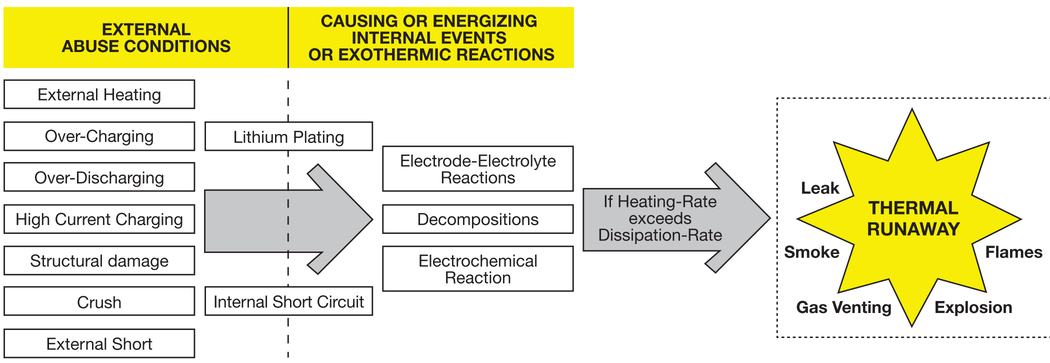






The main factors contributing to a thermal runaway are:

- Poor design or poor integration
- Poor cell or battery manufacturing quality
- Poor safety monitoring or protection
- Poor handling / storage / packing conditions



In-service experience

By their nature and properties, large numbers of Lithium batteries can be found in many places on-board an aircraft (fig.6):

- In the cabin among the personal effects of crew and passengers
- In the cockpit as part of tablets used for flight data support
- In the cargo holds carried as cargo or in passenger baggage
- In the aircraft design.

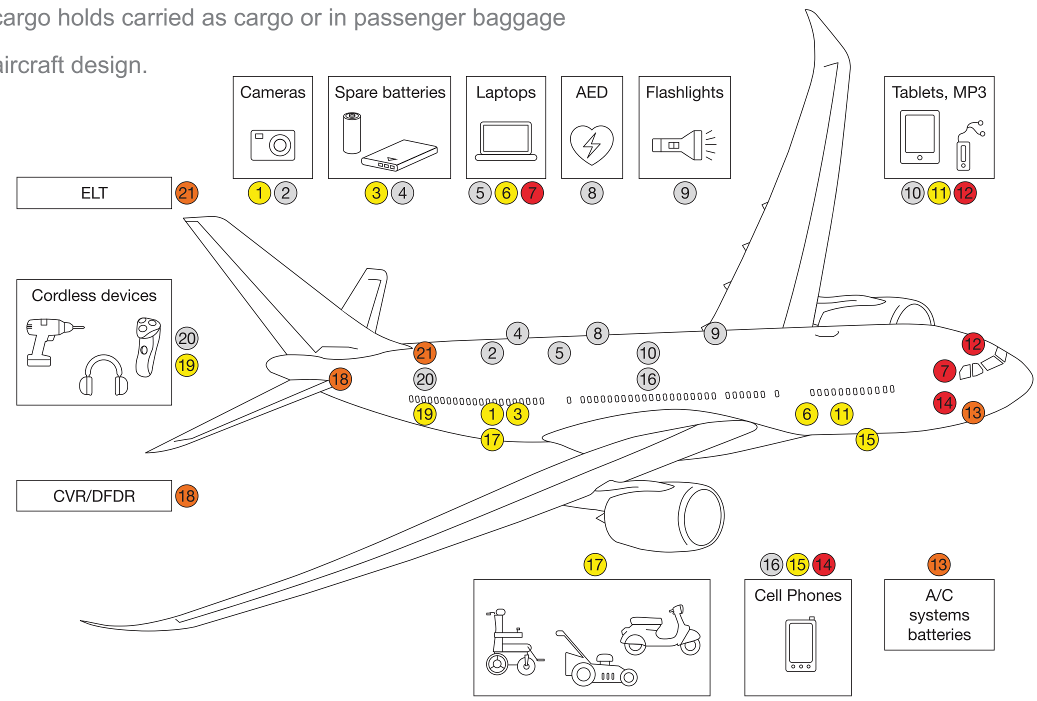


Figure 6: Lithium batteries on-board an aircraft

FAA tests show that even a small number of overheating batteries emit gases that can cause explosions and fires that cannot be prevented by traditional fire suppression systems. In view of the possible consequences, Lithium batteries are classified as hazardous materials, therefore particular care and consideration must be taken to ensure safe operation in relation to use and transport of Lithium batteries (or devices containing Lithium batteries) when in an aircraft environment.

Damage to cabin overhead compartment video camera

Hull loss

Battery fire

Figure 7: Consequences of Lithium battery thermal runaway

How to mitigate the risks posed by Lithium Batteries

Although investigation into reported events highlighted that some Lithium battery fires were due to internal short circuits relating to design, manufacturing or integration shortcomings, many - if not most - fires were caused by abuse by the user. This may be deliberate or negligent abuse or physical damage due to mishandling, but quite often it is unconscious abuse.

Also, while strict regulations for transporting Lithium batteries as cargo exist, several incidents have been related to Lithium batteries being in the cabin. For this reason, a good awareness on risks posed by Lithium batteries of both airlines personnel and their passengers is crucial.

Permanently installed batteries

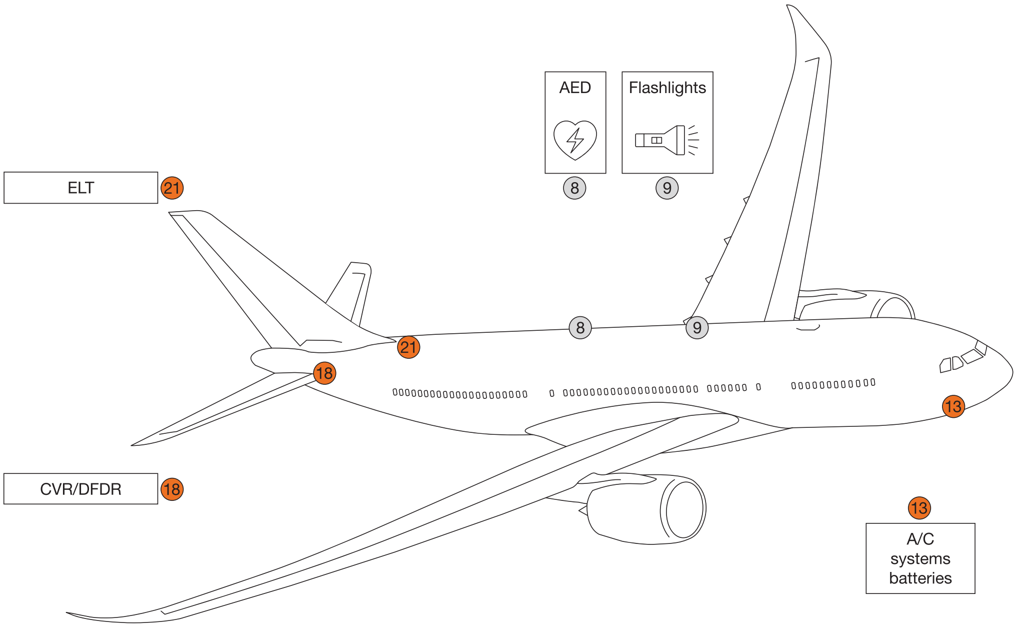
Mitigating the risks posed by Lithium batteries and preventing a thermal runaway, or a fire, starts with securing the batteries that form part of the aircraft design. In this respect, the Lithium batteries embedded in the aircraft design are subject to strict development and integration requirements, complying with the highest safety standards.

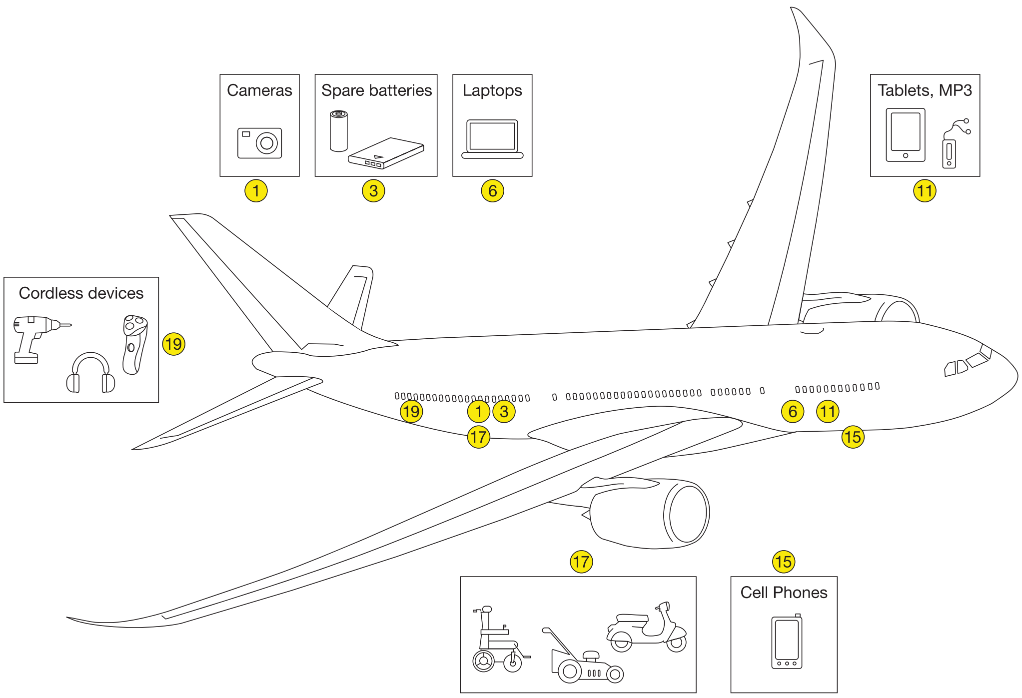
The intrinsic risk of this new generation of Lithium based batteries is acknowledged at all levels of the aircraft design phase, as early as from the inception of the product and its systems. It is then mitigated thanks to acceptability justification based on each battery location, and a thorough review of installation, ensuring that no heat source and hazardous material or fluids are in the vicinity.

During an aircraft's service life, this risk can be mitigated by adhering to common sense precautions, such as using only Original Equipment Manufacturer (OEM) parts. The use of counterfeit or non-authorized parts increases the risk of fire and explosion. Consequently, complying with the Airbus Parts Catalogue and exclusively using Airbus or OEM catalogue references for spare batteries is key. Similarly, before installing spare batteries in Buyer Furnished Equipment (BFE) or in aircraft, operators should ensure the parts are genuine spare parts, that they have been stored and handled appropriately and present no indication of overheat or damage.

Did you know ?

More information about the consequences on use of non-approved batteries can be found in OIT 999.0032/03 Rev 01, OIT 999.0035/04 and OIT 999.0145/14.





Carriage of Lithium batteries as air cargo

Increased usage of Lithium batteries as the power supply of choice has, not surprisingly, led to an increase in the shipping of Lithium batteries as air cargo. Today, one of the main risks posed by Lithium batteries is related to shipping as freight.

The existing ICAO regulations do not regulate the quantity of Lithium batteries that can be shipped as cargo on any single aircraft as a cargo load. The only limitations are associated to what can be loaded into each individual package. It is also worth understanding that these same regulations are not intended to control or contain a fire within that packaging.

What protection can the existing cargo compartment fire protection provide in the event of a Lithium battery fire?

Today's cargo fire protection of an aircraft is addressed by:

- Passive protection (cargo hold linings or protection of essential systems)
- Detection
- Suppression (use of Halon) or oxygen starvation
- Preventing hazardous smoke / extinguishing agents into occupied compartments.

Investigations have shown that the cargo compartment fire protection standards described in CS/FAR25 are not sufficient to protect the aircraft from fires involving high density shipments of Lithium batteries.

"High density" describes a quantity of Lithium batteries that has the potential to overwhelm the cargo compartment fire protection system. In fact, the impact of different characteristics of the batteries (e.g. chemistry, state of charge, size), cargo compartments types and loading confi gurations make it very difficult to define a quantity limitation that could be recommended at aircraft level, for all operational situations. Tests have demonstrated that some configurations, involving only one item of the regulated packaging size, has the potential to lead to significant damage of an aircraft.

Irrespective of the size of the shipment, research into the impact of both Lithium-metal and Lithium-ion battery fires has demonstrated that the existing cargo compartment fire suppression systems – namely Halon 1301 (class C) or oxygen starvation (class E) – are unable to stop a thermal runaway and prevent propagation to adjacent cells. If a thermal runaway is initiated, heat and flammable gases coming from the degradation of the hydrocarbon electrolyte will be emitted. The existing fire protection cargo systems are not capable of containing these accumulated gases.

The passive protection standards are designed to withstand heat sources for up to 5 minutes and are not resistant against the characteristics of a Lithium battery fire. The temperature, duration and intensity of such a fire will quickly overwhelm the passive protections. In addition, the quantity and continuing production of smoke produced is likely to overwhelm the passive and active smoke barriers that protect the occupied compartments.

With these findings, the aviation industry came to the conclusion that today's cargo compartments, which are certified to US CFR Part 25.857 and EASA CS 25.857, do not demonstrate resistance to a fire involving Lithium-metal and Lithium-ion batteries. For this reason, the inability to contain a Lithium battery fire for sufficient time to secure safe flight and landing of the aircraft, is an identified risk to the air transport industry.

Categorization Of Cargo Compartments

Cargo compartments of the Airbus fleet are certified as class C and class E compartments according to CS 25.857. Additionally, some aircraft in service still have class D cargo compartments, but this classification was eliminated for new production in 1998.

- Class C compartments are required for passenger aircraft compartments not accessible during flight (lower deck) or if a fire could not be controlled from the entrance point, without entering the compartment. A class C compartment needs to be equipped with:
  - Smoke/fire detection system
  - Ventilation control
  - Built-in fire suppression system
  - Fire resistant linings (passive protection)
  - It needs to be demonstrated that no hazardous quantity of smoke, flames or fire extinguishing agents are able to enter occupied areas.
- Class D compartments need to be equipped with:
  - Ventilation control
  - Fire resistant linings (passive protection)
  - It needs to be demonstrated that no hazardous quantity of smoke or flames are able to enter occupied areas.
- Class E compartments are only allowed for freighter aircraft. They need to be equipped with:
  - Smoke/fire detection system
  - Ventilation control
  - Only critical systems need to be protected from fire
  - It needs to be demonstrated that no hazardous quantity of smoke, flames or noxious gases are able to enter occupied areas.

What the regulations say

In the light of the risks identified, in January 2015, the ICAO Dangerous Goods Panel took the position to ban the carriage of Lithium-metal batteries of all types, as cargo on passenger aircraft.

However, whilst this was an important development, Lithium-metal batteries only account for a small proportion of all Lithium batteries carried annually as air cargo. Consequently, research into the impact of a Lithium-ion batteries fire has continued. As already noted, this research has demonstrated that Lithium-ion batteries themselves represent a significant threat due to the fact that the existing cargo compartment fire suppression functions are ineffective against a Lithium-ion battery fire.

As a result, regulatory authorities are now heading towards a larger ban on Lithium battery shipments as cargo on passenger planes that would include non-rechargeable and rechargeable batteries alike. At time of publication of this article, these discussions are on-going. At their last meeting in October 2015, the ICAO Dangerous Goods Panel (DGP) proposed a 30% State of Charge (SoC) limit as an interim measure aiming to reduce the risk of fire propagation to adjacent batteries and thereby improve aviation safety.

At the same time, discussions in ICAO are focussing on establishing appropriate packaging and shipping requirements to ensure safer shipment of Lithium-ion batteries. Airbus is also involved in the Civil Aviation Safety Team (CAST) investigating overall approaches from the battery itself, to a combination of packaging / container, and the aircraft itself.

The importance of correct transport and shipping of Lithium batteries therefore becomes key, and the involvement of the shipper and operator is crucial.

What shippers and operators can do: risk assessment and best practices

1. Check the latest industry available information and guidance

Air transport of Lithium batteries is controlled by international and local regulations. If transporting Lithium batteries, operators need to first check the latest instructions for the safe transport of dangerous goods by air, be they provided through Airworthiness Authorities, or local regulations, and/or ICAO.

2. Perform a risk assessment

In the end, the responsibility for the safe carriage of dangerous goods (including Lithium batteries) lies with the shipper and operator. It is recommended that if carriage of dangerous goods is pursued, then a safety risk assessment of cargo operations should be performed to determine if battery shipments can be handled safely.

With respect to Lithium batteries, guidelines for the assessment should consider factors such as:

- The quantity and density of Lithium battery shipment
- The type of Lithium batteries to be shipped
- Who the supplier/shipper of Lithium batteries is and their quality control
- The identification and notification of all shipments of Lithium batteries (also Section II Lithium batteries)
- Accepting only Lithium battery shipments that comply with applicable regulations (ICAO and/or local regulations)
- Overall capability of the aircraft and its systems

- Segregation possibilities of Lithium batteries from other flamable/explosive dangerous goods.

3. Ensure safe packaging and shipping

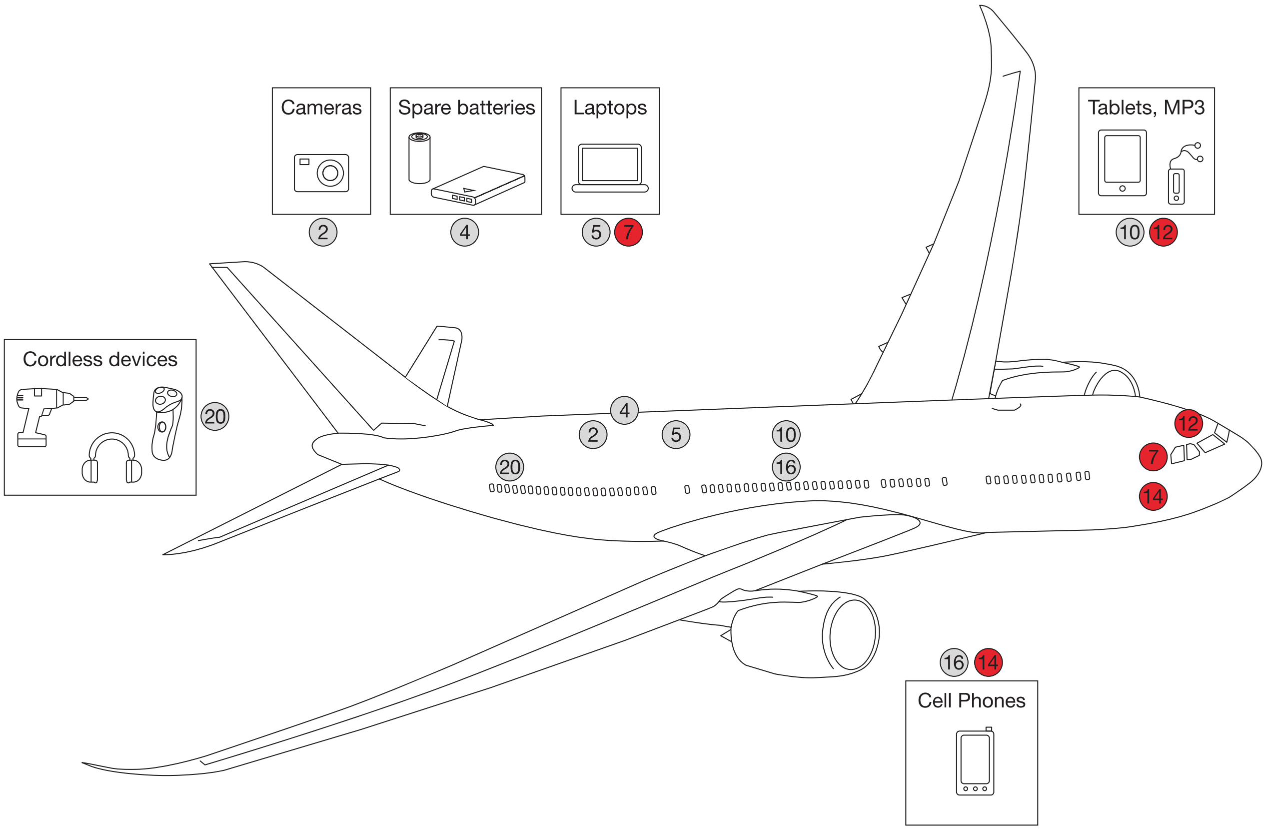
Local and/or international regulations provide the applicable set of rules that need to be complied with when transporting Lithium batteries. Attention should be given to:

- Training and awareness of employees regarding:
  - The aircraft limitations against a Lithium battery fire and existing mitigation means.
  - Regulations, handling procedures, the dangers of mishandling, and methods to identify Lithium battery shipments.
- Packaging:
  - Clearly identify shipments of Lithium batteries by information on airway bills and other documents.
  - Make sure that the packaging is correctly labelled and identified as dangerous goods according to ICAO technical instructions.
  - Do not ship damaged packages.
- Cargo loading: segregate any Lithium battery shipments from other dangerous goods that present a fire hazard (flammable and explosive goods).

Did you know ?

More information on the carriage of Lithium-ion batteries is provided in Airbus ISI 00.00.00182 dated 24 July 2015.

Industry Guidance, such as the IATA "Lithium Batteries Risk Mitigation Guidance for Operators" also provides useful information for mitigating the risk on the carriage of Lithium batteries.



Carriage of Lithium batteries in the cabin

Whilst recent discussions have shifted the focus towards the carriage of large quantities of Lithium batteries as cargo, due to their proliferation and use in many applications, operators need to also be aware of the risk of carrying Lithium batteries in passenger baggage – both checked in, off loaded cabin, baggage and also carry-on cabin baggage.

The widespread use of Lithium batteries means that hundreds of Portable Electronic Devices (PED) are likely to be carried on a large aircraft, either in hold baggage or as carry on. Prevention is therefore essential to raise passengers' awareness of the risks associated to carrying Lithium batteries.

Raising passengers awareness before boarding

Recommendations have been developed with respect to what can or cannot be carried in passenger baggage. ICAO and IATA regulated and recommended general requirements with regards to carrying and managing what is carried in passenger baggage is that:

- Batteries carried should have been appropriately tested (e.g. should be manufactured by the original manufacturer).
- PEDs containing Lithium batteries should be carried in carry-on baggage.
- Spare batteries (i.e. those not contained in a PED), regardless of size, MUST be in carry-on baggage. They are forbidden in checked baggage and should be appropriately protected against short circuit, e.g. by leaving the batteries in its original retail packaging.
- Consider the quantity carried by individuals. Whilst there is no limit on the number of PEDs or spare batteries, below a specified size (normally 100 Watt-hour) that a passenger or crew member may carry, they must be for personal use.

The key however is making both the customer facing representatives and the passengers themselves aware of the risks presented by the incorrect carriage of Lithium batteries, and making sure that they know the regulations. To increase the awareness of the travelling public, posters and Lithium battery pamphlets can be a useful option and are widely used by air carriers and authorities around the world alike. As an example, FAA have issued Safety Alerts for Operators (SAFO) number 15010, which deals with “Carriage of Spare Lithium Batteries in Carry-on and Checked Baggage”.

Raising passengers awareness on-board

A key aspect to mitigating the risk is making the owner, namely the passenger, aware of the risks inherent to Lithium batteries being used in an aircraft environment. Make sure passengers are aware of what is allowed in the terms of Lithium batteries in carry-on baggage, and the requirement for correct storage, but also the impact of a PED getting trapped in the movable seat mechanism.

Due to their small size, PEDs can easily be trapped in seat mechanisms. The subsequent crushing of PEDs during adjustment of the seat can lead to overheat and thermal runaway.

Making passengers aware of this inherent risk can help reduce this scenario. For example, including a note in the pre-flight briefing to ensure that in case a PED is lost, then the seat is not to be moved until the component is retrieved is an option. Likewise, making cabin and flight crew aware of this potential failure mode is key to quick and efficient action when addressing a fire caused by a PED.

Did you know ?

IATA has issued more information on the risk mitigations for operators on carriage of Lithium batteries. Visit their website (http://www.iata.org/whatwedo/cargo/dgr/Pages/lithium-batteries.aspx) for more information and guidance on different situations, making sure the most recent approved versions are used.

Mitigating the risks posed by Lithium batteries: summary

Lithium battery thermal runaways can be caused by design/manufacturing quality/integration, shortcomings or by inadequate compliance with a number of basic rules. The following principles should be adhered to in order to minimize the risk of Lithium battery fires and explosions:

- Ensure that Lithium cells/batteries shipped comply to international standards.
- Ensure that loads conform with ICAO / IATA labelling, packaging and handling recommendations.
- Ensure compliance to the Airbus Parts Catalogue when replacing batteries.
- Ensure that ground, flight and cabin crews are trained and passengers are aware of Lithium batteries specificities.

How to manage the consequences of a lithium battery fire

As detailed previously, proactive action by making passengers and airline personnel aware of the risks posed by Lithium batteries is more preferable than reacting to a fire caused by a Lithium battery. Therefore, knowing what to do in the unlikely event of a Lithium battery fire is essential. The key principles to safely and efficiently tackling a Lithium battery fire, whether it is in the cabin or flight deck, being:

- Keep people away from the fire
- Minimize risks of fire propagation
- Apply specific firefighting principles.

Apply specific firefighting principles

Classical firefighting procedures and fire extinguishing means are not efficient to stop a lithium battery fire.

Halon can suppress open flames, but it is ineffective in addressing the source of fire. Use of water is the best option to allow cooling and limit the propagation to adjacent cells.

Once a lithium battery cell has ignited then the effort must concentrate on cooling the surrounding cells by use of water (or other non-alcoholic liquid) and preventing deterioration of the situation to avoid any fire propagation to the adjacent battery cells.

To this extent specific procedures that provide guidance on managing Lithium battery fires have recently been included for both cabin crew (in the CCOM) and flight

Fight the flames

Fight the heat

Cabin crew procedures

Isolate the source of fire. Reacting to a Lithium battery fire in the cabin starts with isolating the source of fire. Indeed, a smoking battery may explode at any time, due to the highly exothermic thermal runaway.

In the cabin, do not try to pick up and attempt to move a burning device or a device that is emitting smoke.

Prevent propagation by ensuring that no flamable material (fluids, gas, devices) are near the smoking battery. Also relocate passengers away from the burning or heating device.

Fight the fire according to specific procedures

Once the burning / heating device has been isolated, the fire itself needs to be addressed. To this end, three specific cabin crew procedures to deal with Lithium batteries fires have been developed based on the FAA recommendations.

Lithium battery fire procedure

This procedure (fig.8) proposes the use of Halon to extinguish open flames, and water (or a non-alcoholic liquid) to cool the device down.

The recommendation is then to immerse the device in a suitable container (such as a waste bin, or standard galley container) to secure against thermal runaway (refer to the third step below).

LITHIUM BATTERY FIRE

Ident.: **09-020-00015205.0001001 / 28 JAN 14**
Criteria: LR
Applicable to: ALL

The roles of the firefighter, assistant firefighter and communicator must be distributed according to the basic firefighting procedure.

In the case of PED or spare lithium battery fire in the cabin or when notified by the flight crew:

- **If there are flames:**
  FIREFIGHTING EQUIPMENT.. TAKE
  Consider the use of a PBE and fire gloves.
  HALON EXTINGUISHER..DISCHARGE
  Halon extinguisher must be discharged to suppress the flames prior to cool down the PED or the Spare lithium battery.
- **When the flames are suppressed or If there are no flames:**
  ON PED or spare lithium battery.........................POUR WATER OR NON-ALCOHOLIC LIQUID
  The PED or Spare lithium batteries must be cooled down by pouring water or non-alcoholic Liquids
  STORAGE PROCEDURE AFTER A LITHIUM BATTERY FIRE .... APPLY

WARNING	*- Do not attempt to pick up and move a smoking or burning device* *- Do not cover the device or use ice to cool down the device. Ice or other materials insulate the device increasing the likelihood that additional battery cells will ignite.* *- Do not use fire resistant burn bags to isolate burning lithium type batteries. Transferring a burning appliance into a burn bag may be extremely hazardous.*

END OF PROC

Figure 8: Lithium battery fire procedure.

Overhead bin smoke/fire procedure

Lithium battery fires may sometimes not easily be identified, and considering the specific cases when fires have actually occurred in service, the procedure for fire in the overhead compartment (fig.9) now considers as a base that a Lithium battery powered device may be at the origin of the fire.

Therefore the overhead bin smoke/fire procedure now covers the use of Halon and liquid to tackle the fire, and makes reference to the other two cabin crew procedures to address a Lithium battery fire.

OVERHEAD BIN SMOKE/FIRE PROCEDURE

Ident.: 06-020-00004671.0001001 / 28 JAN 14
Criteria: LR
Applicable to: ALL

Smoke/fire in overhead bins may be caused by the contents (i.e. electronic device, spare lithium battery) or electrical malfunction in the Passenger Service Unit (PSU).
The firefighter, the assistant firefighter, the communicator and the support crewmembers must conduct their tasks simultaneously.

- **When smoke is coming from an overhead bin:**

FIREFIGHTER AND ASSISTANT FIREFIGHTER
PBE .... DON

FIREFIGHTER
FIRE EXTINGUISHER .... TAKE

Note: Consider the use of fire gloves.

ASSISTANT FIREFIGHTER
WATER OR NON-ALCOHOLIC LIQUID .... TAKE

Note: Water or non-alcoholic liquid is required if the fire involves lithium battery.

SUPPORT CREWMEMBERS
PASSENGERS .... RELOCATE

COMMUNICATOR
FLIGHT CREW .... NOTIFY IMMEDIATELY VIA INTERPHONE

FIREFIGHTER
OVERHEAD BIN .... CHECK FOR HEAT
Using the back of the hand, feel the overhead bin to determine the temperature and presence of fire.
(*)OVERHEAD BIN .... OPEN SLIGHTLY
Enough to pass the nozzle of the fire extinguisher.

CAUTION	Opening the overhead bin more than necessary can cause contamination of the cabin with smoke, and can result in smoke inhalation.

(*)FIRE EXTINGUISHER .... DISCHARGE

Note: The fire extinguisher must be discharged into the overhead bin, away from the seat, to prevent debris from contaminating the cabin.

(*)OVERHEAD BIN .... CLOSE AND LATCH

Continued on the following page

OVERHEAD BIN SMOKE/FIRE PROCEDURE (Cont'd)

FIREFIGHTING .... REPEAT AS NECESSARY
(*)Repeat last three steps of the procedure, as necessary.

- **When the flames are suppressed:**

FIREFIGHTER
OVERHEAD BIN .... CHECK THE SOURCE OF FIRE

Note: The assistant firefighter must support the firefighter in the case of re-ignition by using fire extinguisher.

- **If source of smoke/fire is coming from a visible PED and/or Spare batteries:**

FIREFIGHTER
ON PED OR SPARE LITHIUM BATTERIES .... POUR WATER OR NON-ALCOHOLIC LIQUID
The PED or Spare lithium batteries must be cooled down by pouring water or non-alcoholic liquids.

- **If the source of smoke/fire is coming from an identified item:**

FIREFIGHTER
IDENTIFIED ITEM .... TAKE OUT
ON IDENTIFIED ITEM .... POUR WATER OR NON-ALCOHOLIC LIQUID
The identified item must be cooled down by pouring water or non-alcoholic liquids.

- **If the source of smoke/fire is coming from a non-identified item:**

FIREFIGHTER
OVERHEAD BIN .... EMPTY WITH CAUTION

Note: Empty the overhead bin until the source of smoke/fire is identified.

ON IDENTIFIED ITEM .... POUR WATER OR NON-ALCOHOLIC LIQUID
The identified item must be cooled down by pouring water or non-alcoholic liquids.

STORAGE PROCEDURE AFTER A LITHIUM BATTERY FIRE .... APPLY

END OF PROC

Figure 9: Overhead bin smoke/fire CCOM procedure

Storage procedure after a Lithium battery fire

This procedure (fig.10) is called at the end of the two previous procedures. Once the fire has been contained and the device can be safely moved, this procedure recommends placing the receptacle where the burning/ heating device was immersed in a lavatory and subjecting it to regular monitoring.

The lavatory is proposed as it contains a means of smoke detection, but is also a location that can secure the device away from the passengers and provides waterproof floor designed to receive water in case of turbulent A330/A340 conditions.

STORAGE PROCEDURE AFTER A LITHIUM BATTERY FIRE

Ident.: **09-020-00015206.0001001 / 28 JAN 14**
Criteria: LR
Applicable to: ALL

- **When the PED or the spare battery can be safely moved:**

FIRE GLOVES.......... PUT ON
RECEPTACLE.......... TAKE

Consider the use of any suitable empty receptacle (e.g. standard unit or lavatory waste bin ...)

RECEPTACLE.......... FILL WITH WATER OR NON-ALCOHOLIC LIQUID
PED OR SPARE BATTERY.......... IMMERSE

Total immersion of the PED or the spare battery will prevent fire re-ignition.

RECEPTACLE..........STORE INTO THE NEAREST LAVATORY
LAVATORY..........SET AS INOPERATIVE
AFFECTED LAVATORY.......... MONITOR

The affected lavatory must be regularly monitored for the remainder of the flight to ensure that the device remains immersed.

END OF PROC

Figure 10: Storage after a Lithium battery fire CCOM procedure

Flight crew procedure

More and more flying crews are taking advantage of the capabilities offered by Electronic Flight Bags (EFBs), the majority of which use Lithium batteries as a primary power source. But Lithium batteries may also enter a cockpit in the form of a flashlight, laptop, tablet, camera, mobile phone,… i.e. any Portable Electronic Devices (PEDs).

With the aim to preventing a Lithium battery fire, the key is to ensure that the EFBs and other PEDs are not exposed to abuse conditions (i.e. dropped or damaged), and if damaged, not used until confirmed serviceable. However, if the feared situation occurs, flight crew procedures have been developed on the basis of key principles: Fly, Navigate, Communicate, with appropriate task sharing. The philosophy of the Airbus "Smoke/Fire from Lithium battery" procedure (fig.11) is:

- One pilot needs to continue flying the aircraft, while the second pilot will address the detected fire. If necessary, transfer control. Usually the fire fighter is the one the closest to the fire.
- Establish communication with the cabin – a Lithium battery fire should be managed as a whole crew concern – to initiate the "Storage after a Lithium battery fire" procedure.
- Secure the safety of the flight crew: the Pilot Flying should don the oxygen mask, while the pilot who will tackle the fire should don the Portable Breathing Equipment (PBE).
- Use Halon to extinguish any open flames.
- Once there are no more open flames:

  - If it is not possible to remove the burning/heating device from flight deck, pour water or non-alcoholic liquid on the device to cool it down. Be aware of possible explosion. Tests completed by Airbus have confirmed that a small quantity of water aimed at the device is sufficient to cool it and mitigate the consequences of the thermal runaway.

  - If it is possible to move the device: transfer it to the cabin and use the Cabin Crew Lithium battery procedures to secure it, by immersion in water or non-alcoholic liquid.

SMOKE/FIRE FROM LITHIUM BATTERY

If necessary, transfer control to the flight crew member seated on the opposite side of the fire

CKPT/CAB COM..ESTABLISH
STORAGE AFTER Li BAT FIRE cabin procedure..........
....REQUEST INITIATION

- **If there are flames:**
  CREW OXY MASK (PF)......................................USE
  SMOKE HOOD (PM)..USE
  HALON EXTINGUISHER......................................USE
- **If there are no flames or when flames are extinguished:**
  - **If not possible to remove device from the cockpit:**
    WATER or NON-ALCOHOLIC LIQUID..................
    ....POUR ON DEVICE
    DEVICE..MONITOR
  - **If possible to remove device from the cockpit:**
    DEVICE.............................TRANSFER TO CABIN

Figure 11: Smoke/fire from Lithium battery QRH procedure

Did you know ?

To know more about Lithium battery fires management in the cabin, and cabin safety issues in general, read our brochure “Getting to grips with cabin safety”, available on Airbus World.

Lithium batteries have existed for more than 20 years now and are widely used in all daily applications. This technology is extremely efficient and its range of applications is constantly expanding. Whilst fortunately events involving Lithium batteries are rare, and even rarer when occurring in flight, the risk of fire still exists. The specificities of Lithium batteries need therefore to be considered in all aspects of aircraft applications and managed correctly – whether carried as cargo, or installed as equipment in the flight deck or cabin, or just as part of the passengers carry-on baggage.

Article contributors include Joerg KLOCKGETHER and Dieter JUST. With grateful acknowledgment to Airbus Safety First publication and to the authors.

Mohammed Al Khayat

Senior Air Accident Investigator
GCAA – AAIS

Passenger Ejected from Hot Air Balloon Basket during Landing

On 10 November 2014, at about 0200 UTC, a Cameron Balloon A-450LW, registration mark A6-BAR, operated by Balloon Adventures Emirates, was conducting a sightseeing flight at Margham, Dubai, with 21 passengers and one pilot onboard. At the end of the flight, and during the landing phase, one of the passengers fell from the Balloon basket to the ground and sustained serious injuries.

On the day of accident the Pilot reported for duty at 0115 and checked the Terminal Area Forecast report (TAF). He then proceeded to the Balloon and checked the weather station at the take-off site. The Pilot decided that conditions were suitable for the flight.

Before the passengers boarded the Balloon the pilot, as part of the Standard Operating Procedure (SOP), briefed them. The briefing included take-off and landing safety precautions, and various other safety requirements. The briefing emphasised the importance of wearing the safety harness and explained how to connect the harness to the floor anchor in the basket. The briefing referred to the need for passengers to keep their backs to the direction of flight during landing, and to assume a landing position by holding the rope handles in the basket with both hands. The pilot also demonstrated the correct landing position.

After the briefing, the pilot divided the Passengers into two groups for the boarding process. At 0145, the passengers started to board the balloon and at 0200, the pilot contacted Minhad Air Traffic Control (ATC), requesting clearance for take-off.

At about 0212, the Balloon lifted off, and the Pilot requested an altitude of 400 ft, which was approved by Minhad ATC. The flight proceeded uneventfully for approximately 21 kilometres over about 48 minutes.

During the flight, the pilot again provided safety information regarding the correct landing position to the passengers. He checked and confirmed that all the passengers were taking the correct landing position. He also believed that each passenger had understood and followed his safety instructions.

Before landing, the pilot asked the passengers to assume the landing position. According to the pilot's statement, all of the passengers had adopted the correct position. This was verified by the in-flight video.

Upon landing, the Balloon bounced a number of times. During the second bounce a 25-year old female passenger lost her balance, and was ejected from the basket. The pilot did not notice that the passenger had been ejected until the balloon finally came to rest. A friend of the ejected passenger immediately left the basket and ran to her aid.

According to the portable Global Position System (GPS) device which was onboard the Balloon, the wind speed was 1 knot (kt) at take-off, maximum climb rate was 689 ft / minute, maximum sink rate was 803 ft/minute and maximum altitude reached was 4,101 ft. The maximum speed of the Balloon was 36 kilometres per hour (19.4 kt), and the landing parameters were within the limits published in the Flight Manual.

The Pilot was a 49-year old male, who had completed approximately 350 flights on type and he held a valid GCAA Medical Certificate. According to the Employee Balloon Technical Log, the Pilot had flown the same incident Balloon for about one hour almost each day for the previous two months.

Balloon Information

Cameron balloons are designed and certified according to EASA CS-31: Certification Specifications for Hot Air Balloons.

Figure 1 illustrates the Balloon configuration.

The Rapid Deflation System (RDS) is a pilot actuated system which opens a section at the top of the balloon to vent the captured hot gases to atmosphere. In the Cameron balloon design, the RDS is actuated by a rope from the pilot's position via a pulley system to the RDS at the top of the balloon envelope.

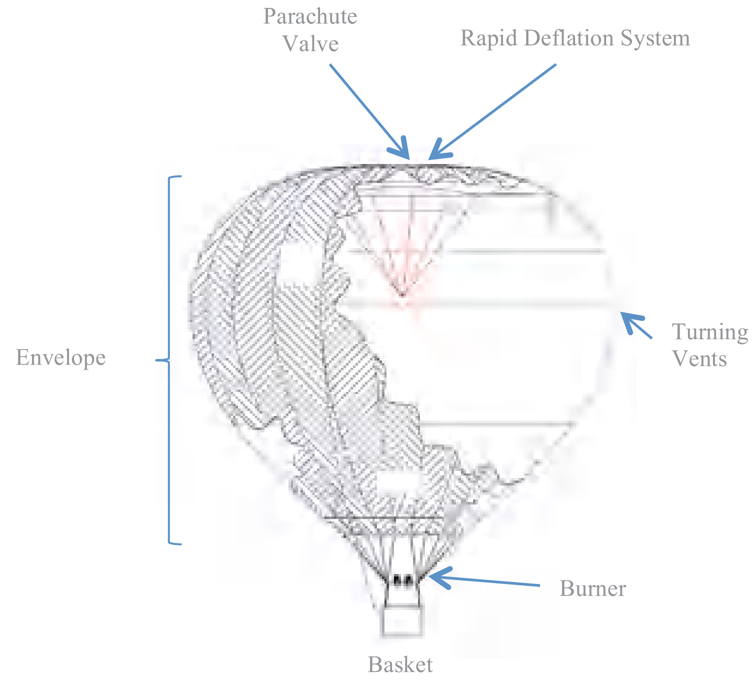


Figure 1: Typical balloon configuration

Communications

The Balloon was equipped with Portable VHF radio communication and a mobile phone. The mobile phone was available to be used in the event that normal VHF communication was not possible.

Flight Recorders

The Balloon was Equipped with a Flytec 6040 flight instrument. This instrument constantly calculates the wind at various elevations and generates a wind layer map showing the wind speed and direction on an automatically adjusting altitude scale. The 6040 has a built-in 3D flight recorder that allows downloading of flight data to a PC enabling flight information to be viewed in FlyChart software, or in Google Earth.

Organizational and Management Information

Balloon flying operations are limited in the UAE because of seasonal variations due to high ambient temperatures, density altitude considerations and localised, regional variations in wind speed and direction. The balloon flying season normally starts in September and ends in June, dependent on the weather, and flying conditions.

Additional Information

Balloon Passenger Basket Landing Briefing:

Passengers are briefed to turn their backs to the direction of flight and to bend their knees while gripping a rope handle attached to the wall of the basket with both hands, the passengers are secured in the basket by a restraint system.

The passenger restraint system consists of two parts:

1. An anchor that is connected to the basket floor.
2. A belt worn around the waist of the passenger.

On instruction from the pilot the passengers connect the anchor karabiner to the ring on their belt before landing. Each passenger must hold onto the rope handle with both hands for the duration of the landing phase, until the basket stops.

Analysis

The Investigation into this Incident collected data from various sources for the purpose of determining the causes and contributing factors.

The pilot reported for duty about one hour and 45 minutes before the flight. He was scheduled to operate one flight only. The Balloon was airworthy, and the pilot was rested. The wind speed, sink rate, and landing weight were within the limits published in the Flight Manual. In addition, the weather and visibility conditions were normal based on the meteorology report.

The flight was uneventful until the first touchdown. According to the injured passenger's statement, the instruction from the pilot on the landing practice was not clear to her. The injured Passenger said that she expected that the landing of the Balloon would be smooth.

Before the passengers boarded, the pilot briefed them about the take-off, landing and flight safety requirements, and he then demonstrated the landing position. The Pilot briefed the passengers on the landing position and landing practise in English, as it was the common language for all of the passengers. All the passengers stood in a semi-circle during the pilot's safety briefing. As part of the briefing the pilot demonstrated how to latch and unlatch the safety harness.

Briefing passengers about safety actions is a pilot responsibility, there was no specific procedure to check each individual passenger's understanding of the instructions and there was no requirement to individually confirm each passenger's compliance with safety requirements.

The injured passenger had no physical ailments that might have affected her hearing, or eyesight, and she understood English. Detailed and specific instructions for landing safety discipline were provided to the passengers by the Pilot. According to SOP Version 1.24 it was not required to check that each passenger was secured by their harness and rope, or that they understood the instructions of the Pilot.

Following the landing briefing given by the Pilot no passenger indicated that they had any problem following his instructions. According to the pilot's statement, all the passengers were standing in the correct position for all flight phases including the landing. This was verified by the in-flight video.

As the Balloon touched down, it bounced several times. This was contrary to the expectation of the passenger who was ejected from the basket. This Passenger had expected a smooth landing. On the second occasion that the Balloon contacted the ground, the injured passenger, who was not holding the rope handles due to her expectation of a smooth landing, lost her balance, and was ejected from the Balloon basket.

The Pilot did not immediately notice that the passenger had been ejected. Once he became aware that a passenger had been injured, he immediately contacted the ambulance service and the injured passenger was transported to the hospital.

Causes

The causes of this Accident were:

a. The passenger was aware of the landing safety procedure, however, she did not anticipate the speed and impact of the landing; and

b. During the landing sequence, the injured passenger did not hold on properly to the rope handles with both hands, as instructed by the Pilot.

Two safety recommendations were made:

i. Enhance safety procedures for passengers by displaying a safety card in each passenger compartment. The safety card should include appropriate safety precautions together with a description and appropriate diagrams of the typical landing characteristics of a balloon.

ii. Prior to landing the pilot should confirm that each passenger has followed the landing safety procedure correctly.

Balloon Incidents

Allen Amsbough

This article was published in NASA ASRS Directline almost 20 years ago. Even after the passage of that many years the information in the article is still relevant today. Also note that one of the books referenced in "Additional Information" at the end of the article was published in 1865. An indication of the pioneering role of balloon flight in aviation. (Editor)

A Little Balloon History

Man's first venture into the air was in a hot air balloon invented by the Montgolfier brothers, papermakers of Annonay, France. The Montgolfier balloon, sponsored by Louis XVI, was flown from the Bois de Boulogne in Paris on November 21, 1783. In attendance were many notables, including Benjamin Franklin. When asked by a skeptic, "Of what use is it?" Ambassador Franklin is reported to have said, "Of what use is a newborn baby?"

Professor Charles, inventor of the gas balloon, was working concurrently with the Montgolfier brothers, and in direct competition for the support of the king. His approach was a balloon filled with newly discovered hydrogen obtained from disassociation of the elements composing water. Professor Charles' creation, the Charliere balloon, flew from the Tuileries on December 1, 1783, and the Space Race was on!

Within a very few years, a third type of balloon was flown by Pilatre de Rozier, also in France. The Rozier balloon combined hot air and hydrogen; a hydrogen envelope inside a hot air envelope was heated so that less valving and ballasting were necessary to maintain altitude control. This soon proved to be dangerous, and the Roziere-type balloon was forgotten until helium became readily available.

All three types of balloons, or aerostats - the Mongolfiere, Charliere, and Roziere - are in use today. Propane burners have replaced wood, straw, and dung in the hot air, or Mongolfiere balloons. Helium, ammonia, city gas, and hydrogen are the lifting gasses used in gas, or Charliere balloons, while Roziere balloons now use a helium inner envelope, with a surrounding hot air envelope heated by propane.

The renaissance of hot air ballooning developed under the guidance of Ed Yost in Sioux Falls, SD, in the early 1960s under a U.S. Navy contract with General Mills. The Yost-General Mills product proved to be more valuable for recreation than for military use, and sport hot air ballooning was reborn. There has since been a steady growth of ballooning in the United States and around the world, and balloons can be seen flying every day. Many flights are in competitive events and rallies. Balloons are also used commercially to give sightseeing rides, and as flying billboards to advertise many products.

Balloon Reports to ASRS

More and more balloonists, or aeronauts, have become aware of and are using the Aviation Safety Reporting System (ASRS) to report safety concerns or perceived violations. A review was performed of 109 ballooning incidents reported to the ASRS from 1990 to 1994.

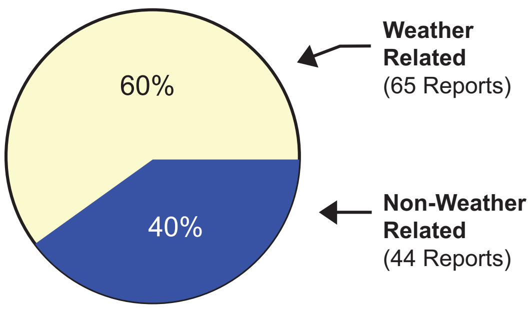


Figure 1: Total Incidents in Data Set

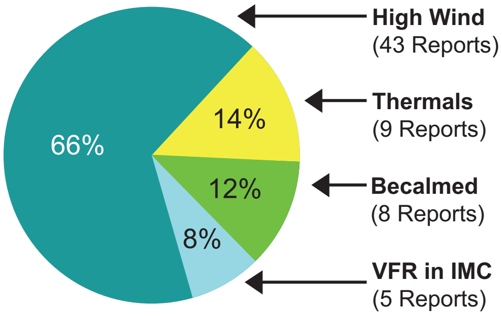


Figure 2: Types of Weather Involvement

There were no reports from gas balloon or airship flights, possibly a reflection of the low level of activity in these sectors. Also, there were no reports from any of the highly publicized long distance or altitude flights. This may reflect the extra caution, care, and planning that goes into these flights, as opposed to the casual weekend sport flight or the flights taken by commercial pilots.

Most of the reporters state that weather and winds were the cause of their incidents. These adverse wind and weather conditions are often found only in a very small area and thus may be termed micro-meteorological conditions. Weather briefers tasked with providing area and airport-specific aviation forecasts may be unable to provide micro-meteorological forecasts or reports about conditions of concern to the balloonist. Consequently, most observation is done by the balloonist on the spot after getting all available official reports. This often leads to surprises, incidents, accidents, and sometimes, to tragedy.

Sixty-five of the 109 reports (60 %) listed weather factors as the cause of the incident (See Figure 1).

As may be seen in Figure 2, forty-three of the weather-involved reporters (66 %) listed unforecast increasing winds as their problem. Nine reports attributed their difficulties to thermals, or other downdrafts, forcing the balloon into the ground. An additional eight reports listed becoming becalmed as the source of their dilemma - not enough wind can be almost as hazardous as too much. One aeronaut became becalmed over trees at sunset, and pulled himself to a clearing by using the treetops. Finally, five reports were received from pilots who found themselves VFR in IMC due to fog or fast-forming clouds underneath.

What Happens in Balloon Incidents

In truth, probably all of the balloon incidents could be considered weather related, as low-level flights to find suitable landing sites, landing in residential areas, and hard landings are usually caused by winds that are not favorable to the balloonist. Even some of the ground incidents undoubtedly involved unreported weather factors.

Airspace Problems

Eleven of the incidents reported involved airspace violations by aeronauts who found themselves inside the edge of Class "B," "C," or "D" airspace without proper radio contact due to a wind shift, faulty or no radio, or faulty navigation. Two aeronauts were intercepted by Air National Guard F-16s while in R-5503. The balloons were flying legally; it was the fighters who were in the airspace early and no NOTAM had been issued.

Airborne Conflict

Midair collisions between balloons accounted for nine of the incidents, with five reporting damage, and one reporting an injury. Most balloon midair collisions are of the "kiss" variety where there is very little relative velocity. Reports concerning damage and injury were of the variety where the lower balloon did not observe common-sense rules in a crowded situation. In one incident, the lower pilot climbed rapidly into a balloon above. The balloon below has the right-of-way because of the lack of visibility, but this does not allow the lower balloon to climb rapidly. In an attempt to preclude this type of mishap, most balloon-meets limit the climb and descent rates to 200 feet per minute.

Six of the reports were from air carrier pilots who encountered balloons in "their" airspace. The gist of their reports was that they were loath to share the airspace and were surprised by the presence of the balloons.

Conflict with Ground and Objects

Seventeen of the reported incidents concerned flights into power lines, the one incident which causes the most fatalities in ballooning. In one third of these incidents, the reporters stated that the power lines were obscured in trees.

More than half reported minor damage, and three reported injuries. There have been other reported injuries, including two broken ankles, to passengers who were not wearing proper footwear in a "ride" balloon. Another ASRS incident record describes one of the more serious types of incidents when working with balloons or airships - attempting to hold the aerostat down by hanging onto a line or the exterior of the basket. In this instance, a crewman lost his grip and fell, breaking an arm and an ankle. No one should ever let his or her feet leave the ground when handling a lighter-than-air vehicle.

They Don't Understand

One of the problems aeronauts find in almost every flight is the notion, "If you're having fun, or doing something unusual, it must be illegal!" This attitude seems to be pervasive among unknowledgeable observers. One reporter describes a balloon landing on a boat in a lake after becoming becalmed. The aeronaut and his balloon were successfully retrieved, only to find themselves on the evening news! Fortunately, the local FSDO was able to laugh with the aeronaut over this. In another incident, a balloon was seen flying through the tops of some trees, an accepted practice to slow forward velocity, and then landed safely in a vacant area. The observer was the local fire chief who "called out the artillery."

The Sky is Falling

Four incidents related to livestock on the ground. One involved a typical "balloon dog" that got upset, then barked and upset its owner. In another report, the balloon spooked some cattle, and in another incident, the balloon flew low over an aviary that was not on the pilot's chart. The most serious incident was the alleged spooking of a horse. Its rider was thrown and suffered a broken arm.

Other Hazards

Balloon fatalities can also result from a propane leak, either in flight or on the ground. Three reporters listed a propane leak - two in the air and one on the ground. In one incident there was damage, and the other resulted in injury. In a fourth incident, an aeronaut reported fuel contamination of an unknown source.

Counting the Problems

Of the 109 incidents studied, 25 reported damage to their balloon or to another balloon; 13 reported injuries; and 25 reported official action taken, mostly by local law enforcement or fire departments. Table 1 lists the numbers and percentages of incidents reported in the 109 reports reviewed for this article.

Table 1 - Balloon Incident Results

Incident	Citations	Percent
Low-Altitude Flight	22	20%
Power Line Contact	17	16%
Landing in Residential Area	17	16%
High Wind / Hard Landing	12	11%
Airspace Violations	11	10%
Miscellaneous	11	10%
Ground Incidents	10	9%
Mid-Air Collision	9	8%
Ground Personnel Perception [2]	8	7%
VFR in IMC	8	7%
Balloon in "Airplanes's" Airspace [3]	6	6%
Livestock Incidents	4	4%
Propane Leak / Fuel Contamination [4]	4	4%
Total	**139**	**128%**

1. Balloon did not fly, or the flight had terminated.
2. Reporter claimed to have done nothing wrong, but was threatened by being reported to higher authority by a homeowner, police, etc.
3. Reported by airplane pilots.
4. One on the ground, two in the air, one contamination.

Multiple citations are possible in any given category, thus the combined totals of citations and percentages shown here are greater than 109 citations and 100 percent, respectively.

The Final Word

Reading these incident reports reminds one that ballooning can be a hazardous sport, but there are actually few injuries and little damage. Nonetheless, the following suggestions may help reduce the potential for incident:

Obtain all available weather information;

Carefully observe local conditions before committing to flight;

If unfamiliar with the micro-meteorology of any area, seek local advice from experienced balloonists;

Brief passengers and crew on all normal and abnormal preflight, inflight, and post-flight procedures.

Allen Amsbough

Allen Amsbaugh died at home in Menlo Park on January 26, 2010, of mantle cell lymphoma, at the age of 77. His lifelong interest in aviation led to a commission in the U.S. Marine Corps as a pilot during the Korean War. After graduating from Stanford University, his professional career was spent as a captain with American Airlines. Much of his recreational flying was done in his hot-air balloon, "Mach Zero." "Cap'n Al" loved to be with people, and he was a member of many groups reflecting his interests: Wings of History, Pacific Coast Aeronauts, Grey Eagles, Moffett Field Historical Society, SIRS, The Westerners, and E. Clampus Vitus.

Additional Information:

For additional information, readers can reference the following books used in preparation of this article.

The Eagle Aloft - Two Centuries of the Balloon in America, Tom D. Crouch,
Smithsonian Institution Press, Washington, DC, 1983

Astra Castra, Experiments and Adventures in the Atmosphere, Hatton Tuznor, Chapman and Hall, London, 1865

With gratefull acknowledgement to NASA Aviation Safety Reporting System (ASRS), to ASRS Directline, and to Allen Amsbaugh.

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Renegade

Linda Werfelman

An overemphasis on assessing aircraft operators' safety management systems (SMS) at the expense of enforcing regulatory compliance is creating new risks that unsafe conditions and practices might go unnoticed, the Transportation Safety Board of Canada (TSB) says.

The agency cautioned that the risk of aviation accidents could increase if Transport Canada (TC) "does not adopt a balanced approach that combines inspections for compliance with audits of safety management processes."

The TSB made the observations in its final report on an Aug. 19, 2013, accident involving a Buffalo Airways Douglas DC-3C shortly after takeoff from Yellowknife Airport in Canada's Northwest Territories for a scheduled passenger flight to Hay River. None of the 24 people in the DC-3 were injured in the emergency gear-up landing, which followed the discovery of a fire in the right engine.

In the report, issued in April, the TSB said that a fatigue crack led to the failure of a cylinder in the right hand Pratt and Whitney R1830-92 Twin Wasp 14-cylinder radial engine and the subsequent engine fire. Although the propeller feathering mechanism was activated, the propeller never became fully feathered, probably because of a seized bearing in the feathering pump, the TSB report said. Investigators were unable to determine the cause of the fatigue crack.

The windmilling propeller resulted in increased drag, and that condition, along with the DC-3's weight — which exceeded the maximum certified takeoff weight — contributed to the airplane's inability to maintain altitude,the report said.The airplane struck trees and the ground short of the landing runway.

The TSB concluded that Buffalo Airways "did not have an effective … SMS in place to identify and mitigate risk in its operations" and that TC's oversight failed to identify those risks. Buffalo Airways, in operation since 1970, conducts passenger and cargo air taxi and airline operations throughout the Canadian Arctic. Its airline fleet is made up of 10 aircraft. In recent years, the operation has been the subject of a cable television series that explores the adventures of what the network describes as "a renegade Arctic airline."

1 Buffalo Airways maintains a company operations manual (COM) for its airline operation. The document, approved by TC, is intended to provide employees with the company's guidance on the handling of normal and emergency procedures.

The TSB report described one section of the manual that details procedures for checking in passengers and cargo. Those procedures call for an aircraft weight and balance calculation to be performed for each flight, using standard passenger weights "unless it is apparent that the passenger does not fit the standard weight," the report said. Carry-on baggage in excess of 8 lb (4 kg) must be weighed, according to the COM.

In March 2010, Buffalo Airways was recognized by TC as an "SMS-compliant" company, and the accident report said that the operator uses "a proactive and a reactive risk assessment reporting system … [to] allow the company to identify issues that may expose the company to risk. Once identified, these issues are assessed and an internal corrective action plan may be implemented to address and correct them."

During the year preceding the accident, neither the proactive plan nor its reactive counterpart identified any issue "relating to operational control, weight and balance or calculated aircraft performance to have been of concern," the report said.

Weight and Balance

The airplane, manufactured in 1942, originally was a military transport C-47B and was converted in 1975 for use in civil aviation. Buffalo Airways has owned the airplane since 1994.

TC had authorized Buffalo Airways' weight and balance control program, and the company was exempt from a Canadian Aviation Regulations (CARs) requirement that large aircraft be weighed, and their weight and balance reports updated, every five years. Instead, the company's program called for recording aircraft weight and balance amendments whenever there was a change in an aircraft's empty weight, the report said.

Nevertheless, the report said, "there were no weighing frequency intervals listed or used in the MCPM [the approved maintenance organization's Maintenance Control Policy Manual]," and the last recorded weighing of the DC-3 was in 1990.

The airplane had a maximum certified takeoff weight of 26,200 lb (11,884 kg). The day of the accident, although the DC-3 was configured for 28 passengers (the maximum allowed), it carried 21 passengers and one flight attendant, along with two flight crewmembers. It also carried 2,707 lb (1,228 kg) of fuel — the equivalent of 1,702 L (450 gal) — and was "loaded with cargo," the report said.

"The [weight and balance] calculation for the occurrence flight had been started by the [first officer] but not completed prior to departure," the report added. "It was common practice to complete the OFP [operational flight plan] and weight and balance en route. … Data from the incomplete OFP indicated a takeoff weight of 21,844.2 lb [9,908.5 kg]. An actual takeoff weight was not determined."

The report said that the passenger manifest did not include the weights of the passengers or their baggage, and that neither had been weighed during check-in, although company procedures called for weighing.

A cargo manifest, which was not made available to the flight crew, listed a cargo weight of 1,071 lb (486 kg).

In addition, the report said that a review of completed OFPs from the company's other flights "indicated the use of passenger weights that were adjusted to facilitate and maintain the weight and balance calculation within limits. When TSB investigators calculated the operational takeoff weight for the accident flight — using standard passenger weights specified by the company's operations manual, OFP data and actual cargo weight — they determined that the takeoff weight was 27,435 lb (12,445 kg), or 1,235 lb (560 kg) more than the maximum certified takeoff weight. The center of gravity was within the manufacturer's limits.

"In this occurrence, a complete and accurate weight and balance report was not calculated prior to takeoff," the TSB report said. "As the aircraft's weight and balance had not been updated since 1990, using actual passenger and cargo weights may not have produced an accurate takeoff weight. As such, the crew would not be able to determine accurately the aircraft's performance capabilities during a normal takeoff. … [A]ircraft operating above the maximum certified takeoff weight (MCTOW) experience a serious degradation in climb performance when experiencing an engine failure with a windmilling propeller.

"Additionally, the company did not have the capability to demonstrate how its aircraft could meet the CARs net takeoff flight path (NTOFP) performance requirements, despite stating this requirement within its operations manual. This puts the safety of flights at risk.

"If companies do not adhere to operational procedures in their operations manual, there is a risk that the safety of flight cannot be assured.

Ineffective SMS

Although the company had an SMS, the TSB found "indications that the organizational culture at Buffalo Airways was not supportive of a system that required the organization to take a proactive role in identifying hazards and risks," the report said.

For example, the practice of in-flight adjustments of weight and balance calculations to indicate compliance with limits was "well known and accepted by senior management," the report said.

Because takeoff performance calculations were not done, even though they were required by the CARs and specified by the COM, and an assessment of obstacle clearance in case of an engine failure had not been done, flight crews may not have fully understood the risks of overweight operations, the report added.

"Previous success in operating the aircraft overweight was likely taken as assurance of future performance without consideration being given to aircraft performance in the event of an emergency," the TSB said, adding that it was "highly unlikely that these unsafe practices would be reported through, or addressed by, the company's SMS."

The TSB report said that Buffalo frequently challenged TC surveillance findings and "initially did not take responsibility for the issues identified" by TC.

"The overall picture that emerged from this investigation is of an organization that met the basic requirements of regulations, and then only when pushed by the regulator," the report said.

Inspections and Audits

Before the implementation of SMS, TC Civil Aviation's oversight of Buffalo Airways consisted of a combination of inspections and audits, the report said, describing "a cycle of repeated inspection findings during which inspections would identify unsafe conditions, the company would take action to address them and, sometime later, the conditions would recur."

TC performed its first SMS assessment at the airline in 2009. The assessment was designed to confirm that Buffalo Airways had, in fact, implemented an SMS. During its investigation of the accident, the TSB reviewed TC's surveillance activities at Buffalo Airways and company responses during the three years before the event. In that time, there had been four surveillance activities: one SMS assessment, one process inspection and two program validation inspections (PVIs); all four activities focused on required elements of the company's SMS.

The surveillance process requires operators to respond to TC findings by submitting corrective action plans (CAPs) that "provide the operator's analysis of the reasons underlying the deficiency and provide an action plan to address them," the TSB report said. TC inspectors then evaluate the CAPs; if they reject a CAP, it is returned to the operator for revision or it forms the basis for a notice of suspension of the company's air operator certificate.

The TSB report said that its review of the CAP paperwork revealed a picture of "an operator at odds with the regulator."

The report added, "In the initial CAP submissions for the December 2011 PVI, the operator took exception to multiple findings, requesting clarification as to the regulatory basis for the deficiencies identified by TC and explicitly questioning the competence and motivation of TC inspectors. TC rejected these initial CAPs, noting that the CAP process was not the appropriate venue for 'repeated diatribes against Transport Canada.' Buffalo Airways revised the CAPs and they were accepted by TC." Two subsequent surveillance activities identified the weight and balance control issues that were discussed in the accident report, the TSB said.

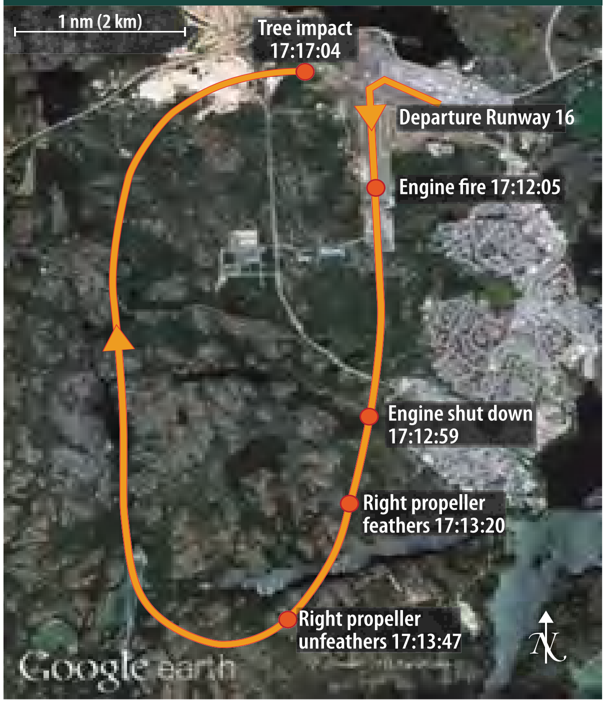
Flexible Oversight

TC conducted four surveillance activities at Buffalo Airways in the three years before the accident, and all four focused on required SMS components, the TSB said. There was no record of TC oversight activity that examined compliance with the CARs or Commercial Air Service Standards, and the surveillance activities did not identify the problems that became apparent during the investigation — overweight operations and the lack of required performance calculations. After the investigation, TC conducted two additional surveillance activities, examining the company's operational control system by using a tool that was designed to verify compliance with regulations. This method usually is used on companies that are not required to have an SMS, the report said.

"While a move towards SMS has great potential to enhance safety by encouraging operators to put in place a systemic approach to proactively manage safety, the regulator must also have assurances of compliance with existing regulations, particularly for operators that have demonstrated a reluctance to exceed minimum regulatory compliance," the report said.

The document added that if TC does not "adopt a balanced approach that combines inspections for compliance with audits of safety management processes, unsafe operating practices may not be identified, thereby increasing the risk of accidents."

The DC-3's brief flight ended after an engine caught on fire and the airplane struck trees during the flight crew's attempt to return to the airport for landing.



Source: Transportation Safety Board of Canada

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The Aftermath

After the accident, Buffalo Airways began weighing individual passengers and baggage and calculating weight and balance before departure. The company also arranged for the development of NTOFP charts and took several steps intended to ensure regulatory compliance. In February 2015, TC approved a revised Buffalo Airways COM that led to several other changes within the company, including the appointment of a new accountable executive and a reorganization of management that calls for the SMS manager to report directly to the accountable executive.

This article is based on TSB Aviation Investigation Report A13W0120, "Engine Failure After Takeoff and Collision With Terrain; Buffalo Airways Ltd., Douglas DC-3C, C-GWIR; Yellowknife Airport, Northwest Territories; 19 August 2013." The report is available at <tsb.gc.ca>.

Note1. History (Canada). Ice Pilots NWT. <www.history.ca/ice-pilots-nwt>.

Buffalo Airways Suspension

Transport Canada (TC) has suspended the air operator certificate of Buffalo Airways, citing the "poor safety record" of the operation, based in Hay River, Northwest Territories, Canada.

The suspension, effective Nov. 30, prohibits the company from providing commercial air services "until it proves it can keep its operations consistently compliant with aviation safety regulations."

Buffalo Airways has been in operation since 1970, conducting passenger and cargo air taxi and airline operations in the Canadian Arctic. The operation has been the subject of a cable television series on History (Canada) about the workings of what the network characterized as "a renegade Arctic airline."

An Aug. 19, 2013, accident involving a Buffalo Airways Douglas DC-3 just after takeoff from Yellowknife Airport drew critical comments from the Transportation Safety Board of Canada (TSB) about TC's regulatory enforcement (ASW, 7-8/15, p. 17).

None of the 24 people in the DC-3 was injured in the emergency gear-up landing, which followed discovery of a fire in the right hand engine. The TSB attributed the fire to a fatigue crack that led to failure of the Pratt & Whitney R1830-92 Twin Wasp radial engine. The crew attempted to feather the propeller, but it never became fully feathered, probably because of a seized bearing, the report said.

In its final report on the accident, the TSB also said that it had found "indications that the organizational culture at Buffalo Airways was not supportive of a system that required the organization to take a proactive role in identifying hazards and risks" and that it often challenged TC surveillance findings.

The report added that the investigation had revealed "an organization that met the basic requirements of regulations, and then only when pushed by the regulator."

With gratefull acknowledgement to Flight Safety Foundation AeroSafety publication and to Linda Werfelman.

ISASI Reachout

Beirut, Lebanon
Hosted by Middle East Airlines

Middle East Airlines hosted the 50th ISASI Reachout Workshop on Continuing Airworthiness, Flight Operations and Aircraft Accident Investigation from 15 to 19 February 2016. The workshop was held at the Middle East Airlines Training Center in Beirut, Lebanon. Captain Mohammed Aziz was the organizing coordinator for the seminar. Chairman and Director General Mohamad A. El-Hout honored the closing ceremony with his presence.

The instructors for the program were Mr. Frank Del Gandio, President of ISASI, and Mr. Caj Frostell, ISASI International Counselor. Captain Mohammed Aziz also participated in the program as an instructor.

At the closing ceremony ISASI certificates were presented to the 57 participants.

Technical content of the workshop

The Continuing Airworthiness workshop included aging aircraft maintenance, repairs and alterations; human factors in aircraft maintenance; maintenance safety and airworthiness; the roles of technicians and inspectors; MEL, MMEL, and CDL; systems and electrical wiring; maintenance training; the regulatory process, and the roles of the regulator and the manufacturer; as well as numerous case studies.

The accident investigation workshop covered the international requirements in aircraft accident investigation (ICAO Annex 13); the organization of an accident investigation agency; planning and organization for investigation; the role of an airline in a major accident investigation; material factors; examples of test and research in investigations; occurrence reporting and incident investigation; crashworthiness and survivability; and investigation case studies and exercises.

Participant hand-outs and materials

The instructors prepared master copies of their training material. Middle East Airlines arranged for reproduction of the presentations in the form of a hardcopy participant handout. The instructors also prepared DVD material for each participant consisting of ISASI documentation and ISASI Forum magazines, ICAO documentation pertaining to accident and incident investigation, and a number of manuals by leading accident investigation agencies.

Frank Del Gandio teaching Reachout #50

Caj Frostell teaching Reachout #50

Conclusion

The Middle East Airlines management personnel in attendance and several participants mentioned with A total of twelve ISASI membership applications were received during the workshop. appreciation that the workshop was a unique opportunity and learning experience.

Two professors and several students from the University of Balamand, Institute of Aeronautics participated in the workshop.

Informal discussions were held with these participants regarding the establishment of an ISASI student chapter, as well as corporate ISASI membership.

The travel of the instructors, their accommodation at the Movenpick Hotel, and the arrangements in Beirut were sponsored by Middle East Airlines. The instructors appreciated the excellent arrangements, the interactions with the airline management and course participants, as well as the exceptional hospitality. The outstanding arrangements and assistance rendered to the instructors were invaluable in all aspects.

Instructors and participants at the ISASI Reachout in Beirut

Naser Al Mesabi

Technical Assistant
GCAA - AAIS

Hazards at Aircraft Accident Sites

Introduction

The GCAA – AAIS Technical Assistant, Naser Al Mesabi, has been researching hazards at accident sites to verify that AAIS preparations are in line with best practice. The starting point for the study involved reviewing the available guidance on the subject. Of particular value is the ICAO cir315 AN/179 which deals with the subject in a practical way and is comprehensive.

Naser has reproduced important sections of the document to serve as a reminder that this is a topic which must always be kept in mind. Of particular interest in our own region is the need to protect investigators from the dangers of heat exposure.

Another consideration is exposure to infection, or disease. A program of vaccinations and monitoring of vaccination expiry dates is essential to prevent adverse health effects.

1. During the Accident Investigation and Prevention (AIG) Divisional Meeting in September 1999, it was agreed that ICAO had a role to play in establishing and maintaining an inventory of hazards peculiar to aircraft accident sites and in the promulgation of related guidance material to States. The meeting noted that the development and updating on a regular basis, of a list of accident site hazards, was essential. The meeting also agreed it was necessary to specify the training required for accident investigators to enable them to avoid these hazards. Based on the meeting's discussion, ICAO developed a study group, to be known as the Hazards at Accident Sites Study Group (HASSG). The study group was to compile a list of hazards peculiar to aircraft accident sites, develop relevant guidance material and determine the associated training requirements for rescue personnel and accident investigators.

2. In response to the proposal, ICAO established the HASSG to develop the guidelines contained in this circular. ICAO acknowledges that these guidelines are evolutionary in nature and may need to be updated periodically.

Working at aircraft accident sites has the potential to expose investigators, and search and rescue personnel, to a wide range of health and safety hazards. These hazards, generated by the damage to structures, systems, components and aircraft contents, will be variable in nature and will themselves be influenced by the factors associated with the accident scenario, e.g. location, weather conditions, environment, security, etc. To protect investigation and search and rescue personnel requires the application of a system of safety management that identifies the hazards present, determines levels of exposure, assesses the risks posed, and introduces effective measures to eliminate or control exposure. Given the unpredictable character of air accidents, the task of applying an effective safety management system can be both demanding and complex.

3. This circular is produced to assist individuals to consider and apply effective occupational safety management practices both to their own activities, and to the activities of the teams that they work with, or for which they are responsible. The circular discusses the nature and variety of occupational hazards, and the management of risk associated with exposure to these hazards.

4. Throughout this circular, with the exception of the definitions in Chapter 1, the use of the male gender should be understood to include male and female persons and the term "accident" should be understood to include "incident".

5. ICAO is grateful for the considerable assistance provided by members of the Hazards at Accident Sites Study Group in the preparation of this circular.

6. Links to web sites from aircraft manufacturers providing information on aircraft hazardous materials can be found on the ICAO Flight Safety Information Exchange website at www.icao.int/fsix/res_aig.cfm.

Terminology

The definitions below are given to ensure that the readers understand the intended meaning of the terms in the context of this circular.

Accident investigator. A person engaged in the investigation of aircraft accidents, incidents and other aviation safety.

Asphyxia. Suffocation as a result of physical blockage of the airway or inhalation of toxic gases.

Dynamic assessment. Factors associated with the specific accident – accident location, specific details of damage sustained, occupants, cargo, fuel load, time of day, etc. that are used to generate an indication of the risk existing at a specific point in time.

Generic assessment. Background information available to all to assist with considering what hazards are likely to be present – aircraft type, age, modification standard, operating category, typical damage, pre-identified hazards, sampling and analysis data. Enables organizations to plan and prepare, train and establish levels of support equipment.

Hazard. Something that has the potential to cause adverse consequences in terms of harm and/or damage.

Investigation. A process conducted for the purpose of accident prevention. It includes the gathering and analysis of information, the drawing of conclusions, the determination of causes and the making of safety recommendations.

Investigator-in-charge. A person charged, on the basis of his or her qualifications, with the responsibility for the organization, conduct and control of an investigation.

Pathogen. An agent that can cause disease, such as a bacterium or a virus.

Pyrotechnics. The art of making and using fireworks.

Response personnel. Trained individuals responding to a distress by performing search and rescue functions, providing initial medical assistance, medical evacuation and recovery to a place of safety, through the use of public and private resources.

Rocket-deployed emergency parachute system. Whole-aeroplane emergency parachute systems.

Toxic. Relating to or containing a poison or toxin.

Vaccination. Inoculation with a vaccine to provide immunity against a disease.

In the aviation industry, occupational health and safety systems have been developed over time to ensure that high standards of occupational safety are achieved for those involved in the manufacture, operation, servicing and maintenance of aircraft. These safety systems utilize well established processes to identify hazards, determine exposure, assess associated risks, and introduce effective measures to eliminate or mitigate these risks. The highly structured and repetitive nature of many aviation industry activities simplifies the task of safety management.

No activity can be absolutely free of risk, but activities can be controlled to ensure that risk is reduced to an acceptable level. If the risk remains unacceptably high, activities will have to be delayed or modified and a new risk assessment carried out. Often, a balance must be struck between the requirements of the task and the need to make the performance of the task safe for investigation and response personnel. This balance may sometimes be difficult to achieve but should always be biased towards safety.

The modern approach to the management of occupational health and safety recommends a process as follows:

Hazards

A hazard is something that has the potential to cause adverse consequences, and the degree of adverse consequences caused by specific exposures is important when determining the risk posed. A wide range of hazards may exist at aircraft accident sites, some of which may not be directly associated with the aircraft wreckage. Hazards may be posed by pathogens (from human or animal remains), cargo, and the nature of the accident location, ground installations, and other factors. Given the wide range of potential hazards at an accident site, it can be helpful to categorize typical hazards, in order to better manage the accident site.

Hazards have been categorized as follows:

Environment — location (both geographic and topographic), fatigue (effects of travel and transportation), insects/wildlife, climate, security and political situation;

Physical — fire, stored energy, explosives, structures;

Biological — pathogens associated with human remains or cargo consignments and state of local hygiene;

Materials — exposure to and contact with materials and substances at the site; and

Psychological — stress and traumatic pressures imposed by exposure to the aircraft accident, and interaction with those associated with the air carrier and related aviation activities.

Environmental Hazards

- The ***accident location*** frequently poses a range of hazards to investigators due to the geographic and topographic location of the site. On land, the site may be located in remote or built-up areas, at altitude or in very difficult terrain; each of these may pose particular hazards. Marine situations can pose their own problems depending on whether the accident site is in shallow or deep water. Recovery issues pose great risk where divers need to be deployed. Just gaining access for preliminary investigation tasks may present personnel with complex decisions. During later investigation and recovery, the simple need for a continuing presence may pose a hazard and expose personnel to risk of injury.

- ***Fatigue.*** Extended journey times, circadian desynchronisation resulting from transmeridian travel, lengthy working hours and demanding working conditions can result in reduced performance as an outcome of fatigue. These are significant issues about which individuals should be aware and for which they should be prepared. Investigators should ensure they understand the physical and psychological demands of their work and when confronted with particularly demanding working conditions, seek medical advice at an early stage. It is recommended that investigators undergo a periodic medical examination to check their fitness for work at accident sites. Early provisions must be made for nourishment, rest and counselling of investigators both during and following their exposure to the accident site.

- ***Insects/wildlife.*** Some sites, particularly in remote areas, will introduce the prospect of exposure to or contact with wildlife. The many insects and larger animals that bite, sting, inject or secrete can cause immediate or long term health problems, some of which can be life threatening.

- ***Climate.*** Extremes of climate are likely to pose problems, especially to unprepared investigators, as can locations where changes in weather can occur suddenly.

- ***Security.*** Criminal and terrorist threats are a feature of the social situation in many regions, even in seemingly safe cities. The advice and support of local contacts should be sought to determine security measures that should be adopted.

Physical Hazards

- ***Fire and flammable substances.*** Fuel is likely to be one of the most common hazards encountered at a crash site. Fuel poses problems due to its flammability and its nature as a harmful substance. In practice, it is the flammable aspect that most needs to be guarded against. There are, however, other health hazards presented by inhalation of fumes and prolonged skin contact that should also be considered. Where available, the advice of an experienced fire officer attending the site should be sought in guarding against fire hazards and in securing fuel tanks and containers of other flammable liquids such as hydraulic fluids. Fire may also be the result of aircraft batteries short-circuiting; this may be caused by impact damage. Prolonged exposure to firefighting agents can also cause skin and respiratory injuries. These agents should be washed off skin and clothing as soon as possible.

- ***Stored energy components.*** Many aircraft structures and systems have the potential to cause injury to personnel. Electrical accumulators or capacitors and emergency power supplies can be hazardous due to their electrical potential and chemical content. Hydraulic accumulators, oleo struts,

- ***Pressurized gases.*** Some pressurized gases are carried onboard aircraft in containers of various designs. The rapid discharge of these can pose a risk of physical injury or of asphyxiation if released in enclosed spaces. Some fire extinguishing agents can also be toxic.

Figure 1: A selection of pressurized containers recovered from aircraft accidents

Pyrotechnics and explosives. Most commercial and many private aircraft carry custom-built explosive charges to initiate escape slides, parachutes, fire extinguishers, cable cutters, flotation gear, deployable emergency locator transmitters, etc. Whilst the activation of these charges may pose only a small direct risk to personnel, the unexpected initiation of the systems that they operate may present a more significant risk.

Damaged and unstable structures. Generally, the hazards posed by damaged aircraft structures will be obvious and most will be readily identified. Situations sometimes arise, however, when persons on site may be exposed to unexpected hazards, for example, if wreckage moves or gives way underfoot. Modern materials, including composite structures, may appear undamaged externally but will have lost structural integrity due to impact and/or heat damage.

Biological Hazards

Accident investigators are at risk of exposure to many biological hazards. Biological hazards may exist in the cockpit, cabin, and cargo wreckage as well as on the ground where bodies and survivors have lain. Since it is not possible to readily identify contaminated blood and other bodily fluids, it is prudent to take precautions whenever working around and in wreckage, when handling wreckage and when performing off-site examinations and tests on wreckage parts.

Precautions must be taken to prevent viruses from entering mucous membranes (such as the eyes, nose and mouth) or non-intact skin such as open cuts or rashes. The accident site may be contaminated with liquid, semiliquid and dried blood and other bodily fluids, fragmented bones, human or animal tissue and internal organs. In the dried state, there is a risk that particles of these substances may become airborne and come into contact with the unprotected eyes, nose and mouth.

As part of the investigation-planning process, appropriate precautionary measures should be taken against biological hazards. Investigators and others who work on-site, or who carry out off-site examinations and tests of wreckage, should take a biological hazard precaution training course and be inoculated against the Hepatitis B virus.

The following procedures should be developed and implemented:

a) a system to maintain records of training and vaccinations;

b) procedures to ensure that the biological hazard area is identified and that precautions are maintained throughout an investigation;

c) procedures for the maintenance of a personal protective equipment inventory;

d) proper methods for donning, removing and disposing of contaminated personal protective equipment;

e) work practices to minimize exposure;

f) procedures for decontaminating investigation equipment and wreckage parts;

g) procedures for shipment of contaminated wreckage parts to off-site examination and test facilities; and

h) procedures to follow when exposure to biological hazards has occurred.

A kit containing personal protective equipment should be made available to each investigator. The kit should include a full cover protective suit, several pairs of latex gloves, work gloves, face masks, goggles, shoe covers and protective boots, disinfection chemicals and a biological hazard disposal bag.

Procedures to be followed at the accident site should include an initial survey for biological hazards in the form of visible blood or other bodily fluids. When there are serious injuries or fatalities, there will often be bodily fluids remaining after the dead and injured are removed. Areas contaminated by spilled blood or bodily fluids should be identified and roped off and have only one point of entry/exit. Only persons using personal protective equipment should be allowed access to the contaminated areas. Any components that are removed from the accident site for examination and testing should be labelled as biohazardous to ensure that they are treated with the same care as exercised at the accident site.

Investigators should always assume that human tissue and bodily fluids are contaminated and, as a minimum precaution, should don a face mask and wear latex gloves under their work gloves when examining wreckage known to contain blood or other fluids. The most common contaminated items include all cabin interior materials, e.g. seat belts/shoulder harnesses, seat cushions, other upholstery and trim materials, and instrument panels. While wearing personal protective equipment in the biological hazard area, investigators should not eat, drink or smoke;

Biological-hazard waste such as clothing and contaminated personal protective equipment should be disposed of appropriately according to local State requirements. Investigators should carefully pull off the outer work gloves first, then peel off the latex gloves and drop both pairs into a biological hazard disposal bag. Contaminated personal protective equipment should never be reused. Exposed skin should be wiped immediately with moist towels, and then washed with soap and water or a solution of one part chlorine bleach to ten parts water. A new bottle of bleach solution should be mixed every day. Contaminated eyes should be flushed with fresh water. Special attention should be given to thorough hand washing after removing latex gloves and before eating, drinking, smoking, or handling contact lenses. Where an investigator or response person suffers an exposure incident involving biological hazards, appropriate and timely medical assessment should be undertaken and any measures indicated by that assessment be taken to ensure the health and wellbeing of the investigator involved.

Investigators should be aware that wearing personal protective equipment in hot and humid climates may result in heat stroke unless precautions are taken to minimize heat stress. Thus, before donning personal protective equipment, a liter or more of water should be consumed. Depending upon the heat and the humidity, and on the amount of physical exertion required, it may be necessary to limit the amount of time that investigators wear personal protective equipment. Once they have left the biological hazard area, removed and disposed of their personal protective equipment and disinfected their hands, investigators should rest in the shade and consume at least a liter of water. It may be necessary to have medical personnel assess the condition of investigators who have experienced heat stress.

Since it is important to minimize the number of investigators, tools and equipment that could come into direct contact with contaminated materials, a minimal number of investigators should be assigned to handle wreckage and disassemble components. Other investigators could be assigned to take notes, draw diagrams, take photographs or use the appropriate manuals and engineering drawings.

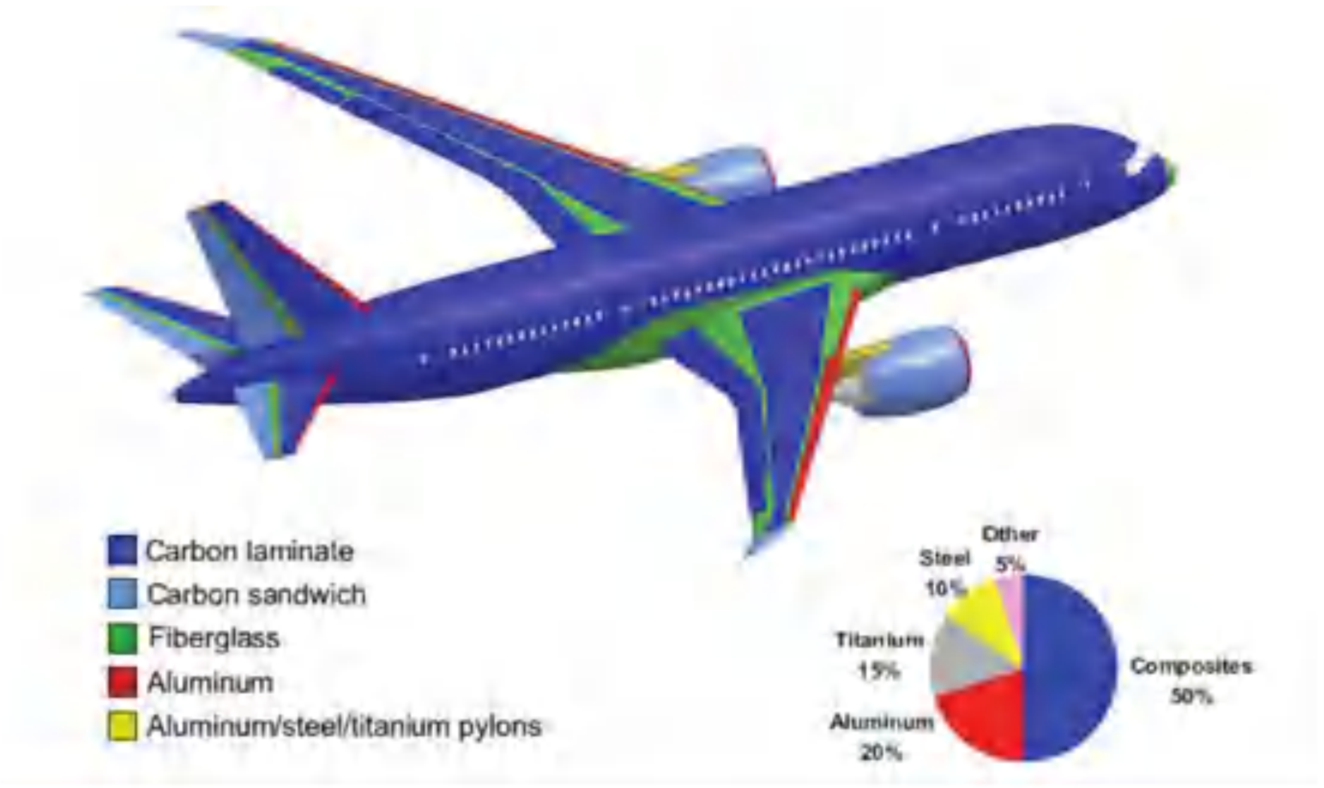
Contaminated investigation equipment, such as tools, flashlights and tape measures, should be cleaned with soap and water, disinfected and allowed to dry. Personnel, when leaving the area, should place in biological-hazard disposal bags any equipment that cannot be readily disinfected. On-site garments should be removed at a decontamination area and clean garments worn in transit to prevent biological hazards from being spread to clean areas off the accident site. The disposal bags and their contents are usually incinerated at appropriate facilities, such as hospitals.

Material Hazards

Damaged aircraft materials can pose health hazards to investigators and search and rescue personnel.

Many States are required by national legislation to control the hazards posed by exposure to hazardous substances.

This requires the identification of hazardous materials found at work, to make an assessment of the associated risks to health, and to put in force suitable measures to control these risks. This is not an easy task as the list of potentially hazardous materials is long. The risk of exposure is highly dependent upon the particular accident profile. Manufacturers and operators are organizations that could assist in compiling lists of materials that may become hazardous when damaged.



Groups of materials that have been considered as hazards to date include:

a) metals and oxides;

b) composite materials;

c) chemicals and other substances; and

d) radioactive materials.

Of these groups, composites have attracted the widest interest in recent times. It is pertinent that they are finding ever wider application and usage in aircraft.

Metals and Oxides. Many of the metals and their respective oxides are hazardous to health when ingested into the body. However, all dusts and particles are considered hazardous when encountered in sufficient concentrations. It requires only relatively small quantities of some metals to pose risks to health and to have a significant effect on the body. These metals and oxides are accordingly classified as high risk. These substances may adversely react with chemicals, such as firefighting agents, so any indication of chemical reaction should be treated with the greatest care and reported to the Investigator-in-charge.

Composite materials. The use of fiber-based composites on aircraft is now extensive, with aircraft structures commonly consisting of more than 15 per cent by weight of these materials. A broad range of fibrous materials is used in the construction of composite materials, including carbon, glass, kevlar and boron, with these and others often combined to form a hybrid fibre. The resin matrix binding the fibre generally accounts for around 40 per cent of the manufactured composite material. These different fibres, not surprisingly, behave differently when subjected to the forces and effects of aircraft accidents.

Chemicals and other substances. Aircraft contain many chemical compounds, some which may be hazardous in their natural state and others which can become hazardous when exposed to heat or other substances.

For example:

- Viton ® is a synthetic rubber-like material containing fluorine used for ‘O’ rings and gaskets in engines and hydraulic systems. If exposed to high temperatures and moisture, the material may degrade and produce a corrosive substance.

- Batteries contain chemicals such as lithium that reacts vigorously with water, and thionyl chloride that decomposes in air to form hydrochloric acid and sulphur dioxide.

- Hydraulic fluids may be hazardous in their normal state, perhaps being classed as irritants. Some also become acidic when exposed to temperatures above a certain threshold.

- Used mineral oils from engines are widely known to be carcinogenic and are identified in specific legislation in some States.

Radioactive materials. Radioactive materials are often used in small volumes in some aircraft components and are frequently carried as cargo in commercial operations, particularly substances for medical use.

Generally, specific radioactivities of these are low, and half-lives are short. However, higher activity material is regularly carried on-board aircraft. Restrictions on packaging these are, however, very strict, ensuring that in the majority of cases, packaged contents will remain effectively inert in the event of an accident.

Cargo. There are immense difficulties associated with identifying and assessing risks posed by cargo. A huge variety and volume of freight is carried by air, most of which is identified in some way, although a significant volume carries only a general description. Dangerous Goods are usually well identified and documented, and information may be gathered (using dangerous goods manifests) at a very early stage to help determine the degree of hazard.

While general cargo, by definition, is considered non-dangerous (in transport classification terms), in general health and safety terms, it is quite capable of posing significant hazards. It should be noted that cargo containing dangerous goods and general cargo may include the chemicals and substances mentioned above. Neither mail, nor private goods, both carried by air in large volumes, carry any indication of contents on their packaging.

Psychological Hazards

Accident investigations frequently require personnel to work in close proximity to disaster and trauma. This work involves dealing not just with the fatally or seriously injured, but with survivors, relatives and colleagues of the victims. The intensity, scale, and (frequently) long duration of the task can present significant potential for adverse psychological impact on investigation teams. After past disasters, there have been reports of rescue workers suffering

from Post-traumatic Stress Disorder (PTSD), causing sleep disturbance, intrusive thoughts and flashbacks.

There is little available evidence to confirm such symptoms amongst accident investigators, suggesting that the psychological impact poses less of a risk to investigators than once thought. However, this more satisfactory outcome may be due to the success of existing safety personnel management practices. These include effective selection processes, the establishment of professionalism at both an individual and team level (including good work practices) and effective peer support.

Generic Operational Safety Planning Guide

Introduction

To assist with introducing commonality across States, it is recommended that, as a minimum, measures for planning and preparation should include:

— establishing training requirements (occupational health and safety) for investigators, support staff and others who are allowed access to an accident site;

— identifying the Search and Rescue procedures and considerations as published in Annex 12 and applicable local regulations;

— establishing generic plans and procedures including a common risk assessment and site control plan;

— identifying a range of personal protective equipment (PPE) and support equipment; and — arranging for assistance from specialist advisors should risk management be beyond investigator's knowledge.

Training. Some States are required to provide training to personnel on various health and safety topics. Blood-borne pathogen awareness training is becoming an accepted standard and is being used as an indication of competence for accident site access. Additional recognized training should also be adopted on hazard identification and risk management.

Plans and procedures. The production of a system of generic plans and procedures is likely to have to meet varying national health and safety legislative requirements. Several States have produced comprehensive guidance documents that include a range of plans and procedures. Plans should at least identify the duties and responsibilities of key personnel as well as the actions required at the various stages of response, and should consider the variable nature of accident sites. The introduction of a minimum common format for site risk assessment and control will benefit investigators and other agencies working at site. A typical format for risk assessment is produced at Appendix A. This form should be considered as an initial document and modified to suit local conditions and resource requirements.

Personal Protective Equipment (PPE) and support equipment. Given the variable nature of aircraft accidents and the conditions in which investigators work, it is difficult to produce a definitive list of PPE. However, a generic list is attached at Appendix B for use as guidance, which can be modified to suit the local situation and State policy. Advice should be sought from health and safety specialists to confirm the suitability of any changes or to help identify additional suitable equipment. A wide range of support equipment is often required to ensure that an operating base can be established in any location. Some of this equipment requires special storage conditions in order to maintain its capabilities and prevent degradation of its usefulness.

Specialist assistance. The nature and scale of some accidents may present risk management situations that exceed the knowledge or resources of investigation personnel. It is prudent to have established support arrangements from specialists to advise and assist in areas such as chemical analysis, radiation protection, disposal, trauma management, health and safety management, and personal protective equipment.

Operational Safety Plan/Site Assessment

Use the operational safety plan/site assessment form as a guide to:

- Identify operation name, location and description;
- Identify all operational tasks;
- List identified and anticipated hazards;
- List control measures;
- Identify who will take action and implement control measures;
- List hazardous material/dangerous goods and their containment measures and mitigation options;
- Plan for and identify circumstances that may require emergency termination;
- Plan for emergency procedures and contacts in response to post-accident hazards;
- Identify an off-site administrative unit to provide periodic briefings and to solicit public inquiries so as to minimize non-operational personnel in the accident site;
- Brief personnel on safety plan during pre-op briefing;
- Identify a central administrative point of contact for processing needs of investigators and collecting information on requests for assistance;
- Designate a specific place and time for a daily (or more frequently if required) meeting of all accident site personnel;
- Have a post-op debrief to identify problems, evaluate injuries, and assess coordination with outside agencies;
- Establish post-op panel to modify operational safety plan based upon new recommendations; and
- Keep a copy of form with operational file.

Ref: Hazards at aircraft accidents sites cir315 AN/179 ICAO

Nuno Aghdassi

Head of Flight Safety
Netjets Europe

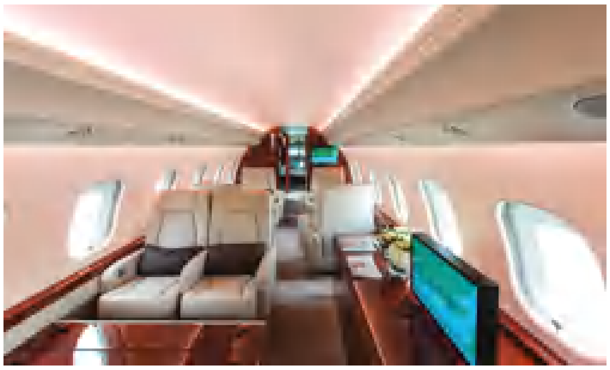
An Operation like No Other

It has been 20 years since NetJets launched its European business and chose Portugal to base its operations centre. It is from Lisbon that we manage our 90-strong fleet of business jets and plan flights to over 700 destinations worldwide. Globally, NetJets operates over 700 aircraft, making if by far the largest business jet fleet in the world. All Lufthansa Private Jet flights are also operated by NetJets on behalf of the German carrier, for their VIP service.

NetJets' operation is unique in many ways. Our 'anytime, anywhere' promise means that flight scheduling is a continuous process which allows customers to change their plans almost anytime, even during the flight. NetJets flies from both large international airports as well as small (VFR) airports, such as Samedan/St. Moritz. Similar to Emirates and Etihad, NetJets employs a very dedicated international workforce that reacts to the high operational tempo, often with frequent short-notice changes. But above all, what attracts customers most are the company's superior safety standards.

NetJets started 50 years ago with the creation of its forerunner Executive Jet Aviation (EJA), one of the world's first aircraft management businesses. In 1984, EJA became NetJets and pioneered the concept of fractional aircraft ownership. In the years that followed, the business grew steadily until 1998 when Warren Buffett (who was a customer) bought NetJets and added it to the Berkshire Hathaway group. From then on, with Berkshire's backing, NetJets has had unmatched resources to invest in whatever is necessary to always be the best and safest player in the industry. Therefore, safety is one of NetJets' core principles – it is part of our DNA.

This is why in Europe, for instance, most of the fleet is being monitored through our in-house Flight Data Monitoring (FDM) programme, and all of our latest aircraft will be delivered with Quick Access Recorders so that they can be monitored from day one, when they join our operation. We were pioneers in applying FDM to business aircraft types when we started over 10 years ago, and we continue to be at the forefront with the expansion of the programme to our entire fleet, beyond regulatory requirements.



Given the variety of destinations and the challenges faced in our operation, our FDM team provides crew feedback in the form of monthly e-mails with their individual performance in order to; for instance, ensure stable approaches and consistent touchdown points, apart from the more detailed analysis of flights with an Honest Broker. The main purpose however is to support our risk management activities and allow us to monitor safety issues through FDM-derived Safety Performance Indicators (SPI) and to share relevant findings with other internal stakeholders, such as Training and Flight Operations. We are active members of EASA's European Operators Flight Data Monitoring (EOFDM) forum and NetJets collaborates with the UK CAA on the development of new event detection algorithms.

While FDM is very good at telling us what happened, it doesn't explain why it happened. This is why another important source of safety data are the reports which we receive through our safety reporting system. This has also seen significant evolution over the years. Initially, when NetJets Europe started in 1996, a paper-based reporting system was used together with the creation of an Access database to keep track of the reports. Later, as the company grew, we introduced a more sophisticated safety reporting system which combined the database with online reporting capabilities into one. Today we are implementing a state-of-the-art safety data management system which will integrate all of our data driven safety management processes and allow us to achieve an enhanced level of oversight of our operation. The common platform will allow NetJets to exchange safety intelligence across the different operations within the group.

To foster an ever improving reporting culture within our company, safety training is provided on a regular basis to flight and cabin crew as well as non-flying operational staff (such as, flight dispatch, maintenance and scheduling). In fact, tailored safety training is mandatory for all employees at NetJets Europe and is delivered in classroom sessions in order to allow better interaction and Q&A. The results of this can be seen in the increasing numbers, content and quality of safety reports received over the years – a clear indication of an evolving safety culture towards a maturing safety management system. An important ingredient of achieving this has been management's commitment and support for the various safety initiatives taken over the last 10 years as well as establishing a just culture at NetJets Europe.

Flight crew fatigue contributes to about 15-20% of overall aviation accidents caused by human error. As a consequence, fatigue and flight time limitations have come under increasing scrutiny over the years, resulting in an industry-wide drive towards fatigue risk management. At NetJets Europe, we started the process in 2010 with the launch of a fatigue reporting form for flight and cabin crew to begin collecting data about potential and actual fatigue situations. We also created an interdepartmental Fatigue Management Steering Group tasked with the implementation of our Fatigue Risk Management System. This initially included a review of procedures and practices which could contribute towards crew fatigue.

A comprehensive awareness programme was also introduced, particularly for crew and schedulers. This year we are completing the implementation of our Fatigue Risk Management System with the integration of a predictive fatigue bio-mathematical model into our flight planning system which will provide schedulers with a real-time estimate of crew members' alertness level. NetJets Europe was one of the founding members of the FRMS Forum and we have been supporting ICAO by presenting at their FRMS Symposium, and by contributing towards the creation of industry-wide guidance material regarding fatigue.

Indeed NetJets' support for industry driven safety initiatives is quite extensive. One example of this was our involvement in the working group which developed the ARMS Risk Management Methodology. The working group, which was led by Airbus and included key players such as Emirates, NATS, NLR, British Airways, EasyJet, Air France and Shell Aviation, was tasked to develop a significantly improved risk management methodology for aviation safety. The ARMS methodology has been in use at NetJets Europe since 2010 for both safety event and safety issue risk assessment. NetJets Europe is also an active member of EASA's European Commercial Aviation Safety Team (ECAST), the Flight Safety Foundation's European Advisory Committee (EAC), the NATS Safety Partnership Agreement (SPA) and the International Society of Air Safety Investigators – European Chapter (ESASI).

In 2011, NetJets hosted the ESASI Annual Conference in Lisbon and brought together over 100 air accident investigators from across Europe and beyond. We also sponsored the ISASI 2015 conference in Germany and plan similar support for this year's conference in Iceland. We are very supportive of the work of the air accident investigation agencies and the lessons we learn from their investigations, many of which are shared with our employees in our quarterly safety publication 'Safety News'.

When conducting our own internal safety investigations, we apply the same principles described in Annex 13 and follow many of the same steps. These include the collection of all factual information (including, for example, safety interviews and FDR/CVR) and an un-biased analysis which culminates in findings and safety recommendations to internal and external stakeholders.

This practice allows us to be prepared whenever we need to work with an air accident investigation agency, in a collaborative and transparent atmosphere, to support an investigation.

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