Allianz Global Corporate & Specialty

Global Aviation Safety Study

A review of 60 years of improvement in aviation safety

In association with EMBRY-RIDDLE Aeronautical University FLORIDA | ARIZONA | WORLDWIDE

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Scope of Report

This report focuses on significant global developments in the commercial aviation sector and air safety in particular, from the beginning of the jet age in 1952 to the present day.

It charts the improvement in the safety record of the industry over this period, identifying key trends and drivers, as well as regional differences. It also identifies and examines potential developments that will impact the aviation sector and the aviation insurance landscape in future.

The findings of this report have been produced with the assistance of Embry-Riddle Aeronautical University, the world's largest, fully-accredited university specializing in aviation and aerospace.

Allianz Global Corporate & Specialty business scope

Allianz Global Corporate & Specialty (AGCS) is the Allianz Group's dedicated carrier for corporate and specialty insurance business, focusing on large corporate and individual risks, often with multi-national or specialist exposures.

These include aviation and aerospace risks of all types from general aviation to major airlines and manufacturers for which we provide cover, both for physical damages ('hull') and for liabilities.

In 2015 Allianz celebrates 100 years of underwriting aviation risks.

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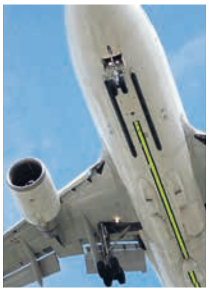
Executive Summary

Aviation safety affects everybody, from passengers and pilots to ground handlers and airline chief executives, to freight companies and the myriad companies who use their services to transport goods around the world. The global population depends on a safe and efficient commercial aviation network. Since the launch of scheduled commercial aviation operations 100 years ago, through the beginning of the jet age 60 years ago, to the present day, stakeholders in the aviation industry have worked continuously to improve the sector's safety performance…



Just one of 75 fatal accidents over a decade can be attributed to system failure ► page 17

With some 58 million jobs across the globe and $2.4 trillion in economic activity dependent on the aviation sector[1] its safety is critical to the health of the global economy. It is estimated over a third of the value of goods traded internationally are delivered by air. Moreover the industry is growing.

By 2050 it is estimated that some 16 billion passengers – equivalent to more than double the current global population of around seven billion – will need to be flown yearly[2] an anticipated increase of 384% compared with the 3.3 billion passengers expected to fly during 2014[3]. In 1960 just 106 million passengers flew worldwide. In 2014 50 million tons of freight will be flown across almost 50,000 routes[4]. By 2050 this is expected to increase significantly to 400 million tons[5].

Aviation incidents will always captivate both media and public attention as 2014's tragic and extraordinary activity has demonstrated – by the end of August three of the 10 major non-natural catastrophe insurance losses of 2014 could be attributed to plane crashes. However, the recent air disasters don't necessarily reflect any major systemic problems with safety. This year's loss activity is contrary to the low catastrophe rate of recent years with 2012 ranked as the safest year of flying since the beginning of the jet age in 1952.

Although the aviation sector has experienced robust growth since the dawn of this era, the past 60 years have seen an ongoing decline in fatal accidents, underpinned by a continuous improvement in safety.

There are currently fewer than two passenger deaths for every 100 million passengers on commercial flights. By comparison during an early decade of the jet age, (1962 to 1971), there were 133 passenger deaths out of every 100 million passengers. Overall analysis of aviation safety shows improvement in every decade since the 1950s.

In 1959 an individual would face the chance of being in a fatal accident once out of every 25,000 departures in the US and Canada. Today, the odds of dying in a crash aboard an airplane in the US or the European Union are calculated to be 1 in 29 million. The odds of being killed by lightning are 1 in 10.5 million. The odds of dying while riding a bicycle are 1 in 340,000 or about 100 times greater than flying.

1 IATA annual review 2014
2 IATA Vision 2050
3 IATA annual review 2014
4 IATA annual review 2014
5 IATA Vision 2050

How innovation impacts safety and the human factor

A number of design implementations have had a dramatic impact on aircraft accident rates, helping to significantly reduce risk, including aerodynamic and airframe improvements, fail-safe design criteria, improvements to cockpit instrumentation and displays and winglets. The increasing number of fly-by-wire controlled aircraft in operation has had a significant impact.

Much of the improvement in aircraft accident rates has been due to engine improvement. The reliability of the modern jet engine has provided a level of safety and confidence for the traveling public unmatched by piston-driven engines.

Engine manufacturers have almost eliminated the chance of an engine failure. Radio and avionics are extremely precise and systems integration provides extra information and backup. Current navigation systems have the capability to determine an aircraft's position to the thousandth of a mile. Meanwhile, aircraft data collection devices can record thousands of parameters, increasing the understanding of operations and accidents.

Improvements in science have allowed the industry to better understand how human factors can affect safety. Pilot fatigue, pilot training, crew resource management, and other factors have become increasingly relevant. A better understanding of the system and its parts has resulted in improvement in manufacturing processes, aircraft operations, industry culture and government regulation. ► **page 34**

Innovations such as digital message communications systems – enabling pilots and controllers to "text" each other – and electronic flight bags aim to further enhance the aviation safety environment. ► **page 31**

Improvement drivers

The long term improvement in global airline safety is due to a combination of several positive trends. Aircraft have become more reliable while safety systems and culture have improved enormously. At the same time the standard of training of crew has become notably higher. Improved air traffic control technology and better collision avoidance systems have also impacted.

Pilots now have much more live information at their fingertips, including more accurate and up-to-date weather data. Safety inspections are now far more effective. Aircraft inspections are much more detailed and stringent than in the past and have been quick to incorporate improved technologies. This means problems are increasingly being identified and dealt with long before they become a significant issue.
Another major factor has been the increased use of recurrent training, which refreshes the skills of pilots and crew, as well as helping them prepare for unusual or emergency situations. This had a significant impact in reducing accidents and therefore insurance claims.

Regional variations in safety

Aviation safety varies across different regions of the world. The state of industrialization is often related to the safety of that region. The Africa region is the poorest performer with standards in some of the more remote parts of the continent, comparable to those of 50 years ago in the US or Europe. ► **page 25**

More than one-fifth of the world's air accidents occurred in Africa in 2011. In 2012 88% of global aviation fatalities occurred in Africa (45%) and Asia (43%). Africa currently uses the highest percentage of second generation aircraft – over 50% of the total fleet analyzed. Upgrading the airline fleet to current generation aircraft is one of the safety initiatives which have lowered the global accident rate.

However Africa was one of the regions which saw its safety performance improve last year compared to 2012. Latin America and the Caribbean was the other. North Asia and Europe were unchanged. CIS had the worst performance after having no Western-built jet losses in 2012. ► **page 26**

Key facts and figures

From established and projected trends, the average lifespan of a typical commercial aircraft is about 25 years. Historically, aircraft experience a higher failure/accident rate when they are first introduced and at the end of their designed life span. Analysis shows 27,065 active aircraft as of May 1, 2013. ▶ **page 16** Accident rates by airplane type ▶ **page 18**

Since 1959 there have been 29,306 onboard fatalities *(as of May 2014)* in the worldwide scheduled commercial jet fleet, the majority of those fatalities happening within the first 20 years after the beginning of jet service. ▶ **page 10**

Analysis over 10 years (2003-2012) shows most accidents occur during descent and landing (57%), followed by the takeoff/climb stage of the flight (24%). Just 9% occur during the cruise stage. All phases of flight experienced a reduction in the accident rate through 2003-2012 compared with previous analysis (1953-1993). Much of this improvement has been the result of improved navigational and approach instruments. ▶ **page 19**

Approximately 90% of aircraft accidents are categorized as survivable ▶ **page 21** However, data from the University of Texas shows 98% of all flights face one or more “threats”, with an average of four threats per flight. Errors have also been observed on 82% of all flights with an average of 2.8 per flight. ▶ **page 36**

In commercial aviation operations, it is estimated 70% of fatal accidents are related to human error with pilot fatigue a major contributor. Risk of fatigue of the operating crew contributes about 15% to 20% to the overall accident rate. Initiatives such as crew resource management, safety management systems and the automated cockpit have played a part in increasing safety levels but the latter can also pose challenges if training is inadequate. ▶ **page 34**

As a result of the introduction of the Enhanced Ground Proximity Warning System (EGPWS) the risk of controlled flight into terrain is now 50 times less in Western Europe and North America than it was in 1991, making this one of the biggest safety success stories in the history of aviation ▶ **page 31**

Ongoing challenges

Regional accident rates can be hard to calculate and compare. Many different agencies or states have varying definitions. In addition, in some cases, foreign civil aviation authorities misreport their compliance with international aviation standards ▶ **page 24**

There are regional differences. In some parts of the world human factors, safety awareness and training are a bigger risk than in others. In some developing countries where modern equipment and aircrafts are in use, the pilots and ground crews do not quite have the same level of training as for example in Europe and North America. ▶ **page 22**

Improved aviation technology and training has led to a higher level of air safety in the US and elsewhere. However, this also means many people in the aviation industry have not been involved in a major accident. This lack of experience is one of the biggest problems in emergency response preparation. ▶ **page 34**

Ramp accidents cost airlines $10bn a year. Ineffective communication is at the heart of most incidents. Contact between airplanes and ground-service equipment accounts for 80%+ of incidents. ▶ **page 40**

A number of high-profile incidents have raised the question of whether pilots are too reliant on automation in the cockpit. Pilot training has changed and improved, but more focus should be placed on continuous training with pilots flying with and without automation. There has to be better preparation of pilots to fly and recover the aircraft if the automation fails. It is clear that improvements have to be made. Pilot training needs to be changed to address this issue. ▶ **page 38**

Insurance impact

The much-improved safety environment is reflected in the fact that premiums for aviation insurance were at their lowest levels for many years, prior to 2014’s loss activity.

However, there has been a 50%-plus increase in exposure (ie the potential loss) since the turn of the century, driven by increasing fleet values and more passengers. Exposures increased from $576bn in 2000 to $896bn[1]. This means that if exposure growth continues at the same rate, we can expect it to break through the $1trn barrier by 2020 or even earlier. ▶ **page 44**

1 Source: Aon Airline Insurance Outlook 2014

In analysis of large insurance claims in excess of $1.36m (€1m), unsurprisingly, plane crashes are the major cause of loss for the aviation sector in terms of number of insurance claims generated (23%) and their subsequent value (37%). Over/undershot runway incidents ranked second according to value (22%). Almost a fifth (18%) of aviation claims relate to ground handling claims and 16% to mechanical failure. ► **page 45**

Huge improvements in aviation safety may be leading to fewer catastrophic losses over the long term but technology brings its own vulnerabilities with the cost of aviation claims rising, driven by the widespread use of new materials, as well as ever more-demanding regulation and growth of liability-based litigation.

Composite repairs require the relevant expert technicians, often in limited supply. As a result, new generation aircraft take more time to assess damage and repair, leading to more down time and more expense. At the same time, the cost of repairing older aircraft is also increasing. Ageing fleets are more expensive to repair as the availability of parts becomes more problematic. ► **page 45**

Emerging risks

Business interruption (both physical- and non-physical damage) and supply chain risks are currently the greatest concern for aviation practitioners with risk of grounding due to factors such as product recall and delays an additional driver of exposure.

Intensified competition and market stagnation/decline, natural hazard risk, regulatory change and technological innovation also rank highly on the risk register. Threat of terrorism is an increasing concern year-on-year based on initial findings from the upcoming Allianz Risk Barometer 2015. ► **page 51**

Scientists have found turbulence will increase in the North Atlantic flight corridor in future due to the changing climate. The chances of encountering significant turbulence could increase by between 40% and 170% on the flight corridor, where 600 jets travel each day. More severe episodes can injure passengers and cause structural damage to planes, costing an estimated $150m a year. ► **page 53**

Cyber attacks could become the "weapon of choice" against the aviation community. There is increasing concern about the impact a large scale cyber attack could have given the sector relies on computer systems for almost every aspect of its business. Data breaches and cyber terrorism are perceived to be growing risks. New generation aircraft face increasing threats due to the more prevalent use of data networks, computer systems onboard and navigation systems. Indeed, the whole sector is facing major cyber risks on all fronts. ► **page 58**

Pilot shortage, the threat posed by lithium batteries in flight and the expected increase of unmanned aerial vehicles (UAVs) in commercial use are among the other emerging risk trends to watch. ► **page 55**

Damage from foreign objects continues to be an issue, with this being the fifth highest generator of insurance claims by number. Bird strikes are a notable cause of loss in this area, with claims also arising from incidents with zebras and cows. Attempts are being made to reduce such incidents happening. ► **page 56**

MH370 – implications for aviation safety

The tragic loss of MH370 has again highlighted the challenges of air traffic management in keeping track of more than 30 million flights a year.

Safety requires close cooperation between regulators, airlines and other stakeholders; with the sharing of data and best practices, as well as effective consultation processes and communications.

Previously, there has not been a widespread requirement for airlines to deploy satellite tracking technology. However, the satellite communication landscape is changing dramatically and in orbit capacity has grown drastically. This situation opens up opportunities to change the status quo.

Innovations such as a cloud-based black box could represent a quantum leap forward, allowing aircraft to stream real-time data about the aircraft systems which are normally recorded by the on-board black boxes. Having the flight data recorder and the cockpit voice recorder information available without having to find the physical box would eliminate the "what happened?" issues in aircraft accidents. ► **page 46**

Safer skies

Aviation accidents and incidents will always captivate both media and public attention, as 2014's tragic and extraordinary activity has demonstrated, but over the long-term the industry has continued to improve its safety record.

This year has been an extraordinary one for the commercial aviation industry. By the end of August three of the 10 major non-natural catastrophe insurance losses of 2014 could be attributed to plane crashes*.

On March 8, 2014 Malaysia Airlines flight MH370 left Kuala Lumpur bound for Beijing, China with 239 passengers and crew on board. An hour later it vanished with the fate of those aboard the aircraft unknown, triggering a huge international search operation across vast swathes of the Indian Ocean.

Then four months later Malaysia Airlines flight MH17, a scheduled international passenger flight from Amsterdam to Kuala Lumpur crashed – reportedly after being shot down by a missile – on July 17, resulting in the deaths of 283 passengers and 15 crew. The plane lost contact over eastern Ukraine before crashing near Torez in Donetsk Oblast, Ukraine, a short distance from the Ukraine/Russia border.

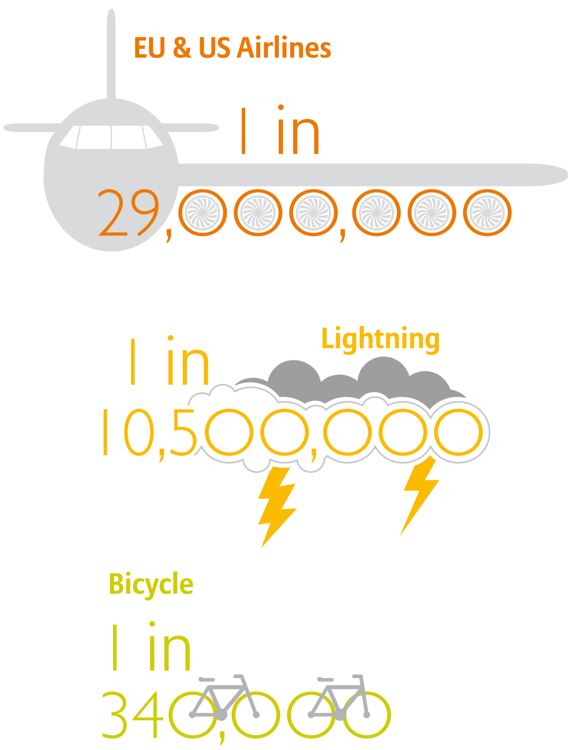
Investigations into both of these very unusual and unconnected incidents are still ongoing. Yet at the same time the aviation sector has sustained further losses such as the Air Algerie AH5017 flight which crashed near the Malian town of Gossi, killing all 118 people aboard on July 24.

Outside of the top 10 major reported non-natural catastrophe insurance losses other notable aviation incidents through 2014 include the loss of a TransAsia Airways plane – within 24 hours of the Air Algerie incident – which crashed as it flew from Taiwan's southern city of Kaohsiung to Penghu, with the loss of 48 people. Meanwhile, in February, a commuter plane crash in Nepal resulted in the loss of 18 people.

* Global Claims Review 2014, Allianz Global Corporate & Specialty

Danger of death...

What are the odds?



Source: Statisticsbrain.com, The Economist.
Graphic: Allianz Global Corporate & Specialty

However, anyone with a fear of flying should bear the following in mind. Analysts say the recent air disasters do not necessarily reflect any major systemic problems with safety. And this year's loss activity is contrary to the low catastrophe rate of recent years, particularly in the US and Europe. Indeed, based on the worldwide number of fatal accidents, in recent years the aviation sector has been at its safest level since the beginning of the jet age in 1952.

Continuous improvement

The aviation sector has experienced robust growth since the dawn of the jet era. Yet the past 60 years has also seen a decline in fatal accidents underpinned by a continuous improvement in safety.

In the US, flying has become so safe over the past five years that a passenger could fly every day for an average of 123,000 years before being involved in a fatal crash according to Massachusetts Institute of Technology (M.I.T).

In fact, last year it was safer to board an airplane and fly to your destination in the US than to use an elevator to climb a few floors, with 30 elevator-related fatalities recorded in the same year[1].

Today, the odds of dying in a fatal crash aboard an airplane in the US or the EU are calculated to be 1 in 29 million, compared to being killed by lightning (1 in 10.5 million). The odds of dying while riding a bicycle are 1 in 340,000 or about 100 times greater than flying[2].

According to the Associated Press' analysis of government accident data, between 2001 and 2012 there were only two passenger deaths for every 100 million passengers on commercial flights. In comparison, during an early decade of the jet age, (1962 to 1971), there were 133 passenger deaths out of every 100 million passengers *(see chart right)*[3].

Globally in 2013 there were 16 fatal accidents* and 210 fatalities, according to the International Air Transport Association (IATA). In the US the last fatal commercial accident was in July 2013 – Asiana Airlines Flight 214 (*see page 39*) - while there were no fatal commercial aviation accidents in the European Union (EU) last year.

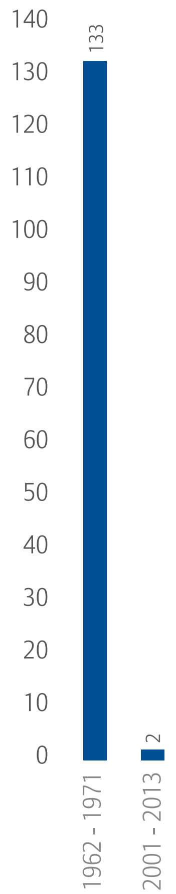
The 210 passenger fatalities recorded in 2013 represents a 50% year-on-year decline compared with 414 in 2012. This means there is currently less than two passenger deaths for every 100 million passengers on commercial flights.

Improving safety is reducing the amount of accidents and incidents. An overall analysis of aviation safety since the 1950s shows improvement in every decade with the number of fatal accidents having been significantly reduced since the beginning of the commercial jet aircraft era. The fatal accident rates from 1959 are shown *on page 10*. The accident rate is a measurement used to determine how safe flight operations are and is measured by number of accidents per million departures.

In 1959 the annual accident fatality rate per one million aircraft departures was between 27 and 40 accidents. Aircraft operators in the US and Canada experienced the higher annual fatality accident rate. Within 10 years the annual fatal accident rate per 1 million departures had decreased to less than two for the US and Canada and six for the rest of the world.

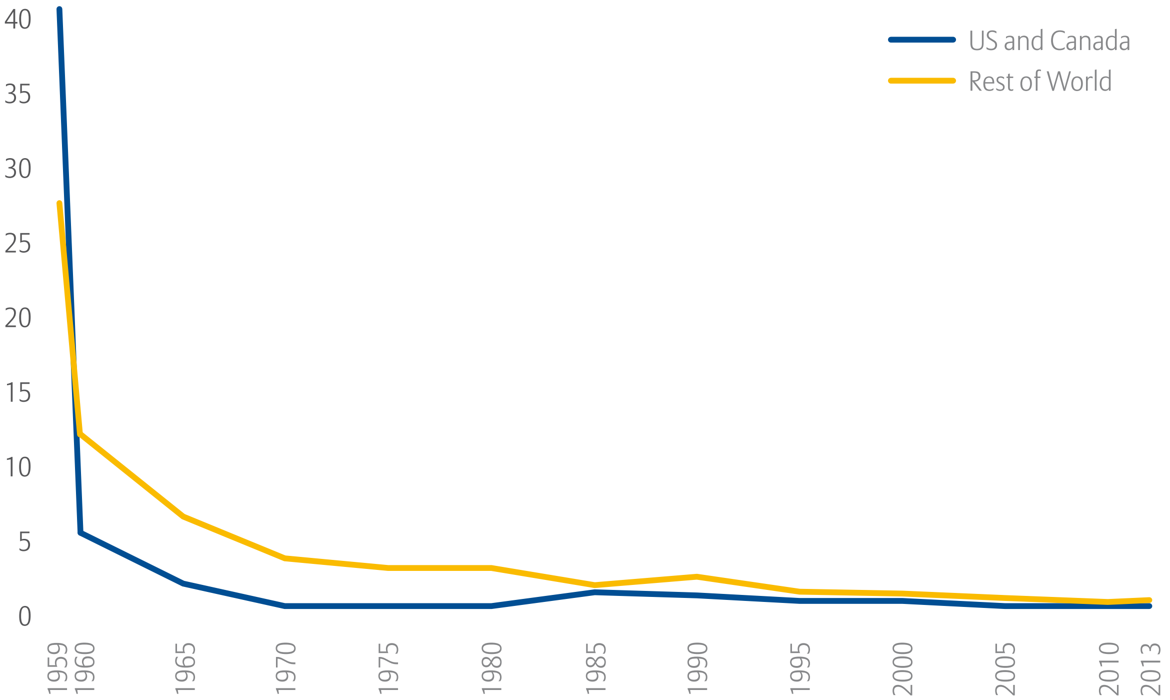
* By definition a fatal accident does not distinguish between a crash with 200 passengers on board resulting in one fatality and a crash with 200 passengers on board resulting in 200 fatalities.

Deaths per 100 Million Passengers



Sources: Washington Times, Associated Press, Embry-Riddle University, Allianz Global Corporate & Specialty

Worldwide annual fatal accident rates per 1 million departures



Source: Boeing Co. Statistical Summary
Graphic: Allianz Global Corporate & Specialty

Since then annual fatal accident rates have continued to decrease. Currently, worldwide fatal accident rates are just over .01 per million for the US and Canada, and .035 for the rest of the world[4]. In 1959 an individual would face the chance of being in a fatal accident once out of every 25,000 departures in the US and Canada. Today those chances would be reduced to 1 in 29 million. Since 1959 there have been 29,306 onboard fatalities (*as of May 2014*) in the worldwide scheduled commercial jet fleet, the majority of those fatalities happening within the first 20 years after the beginning of jet service[5]. As previously mentioned there were just 210 fatalities worldwide in 2013.

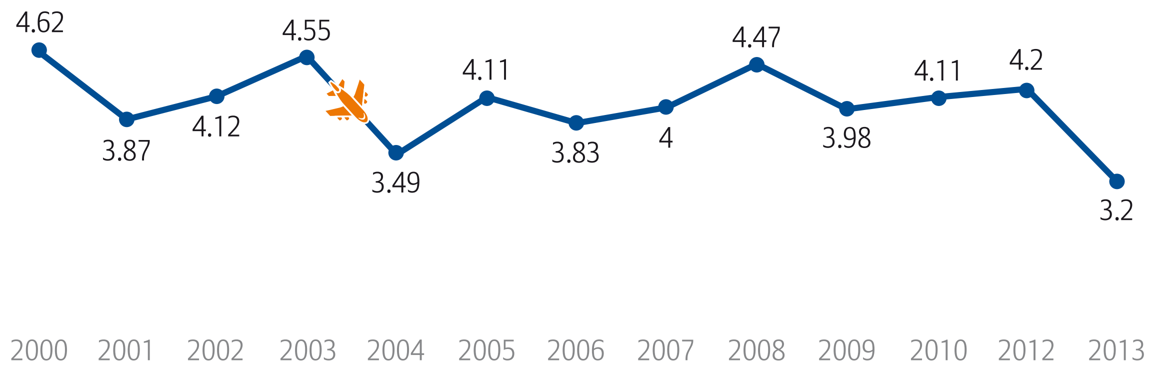
A number of design implementations have had a dramatic impact on aircraft accident rates, helping to significantly reduce risk.
Photo: Shutterstock

"In the past **30 years** in particular **air safety has evolved** greatly, underpinned by **technology**, **navigation systems**, **reliable airframes** and **engine improvement**. This **evolution** is ongoing and will **continue** in the **future**."

Joe Strickland,
Global Head of Aviation, Americas AGCS

Photo: Shutterstock

Global Accident Rate per 1 Million Departures



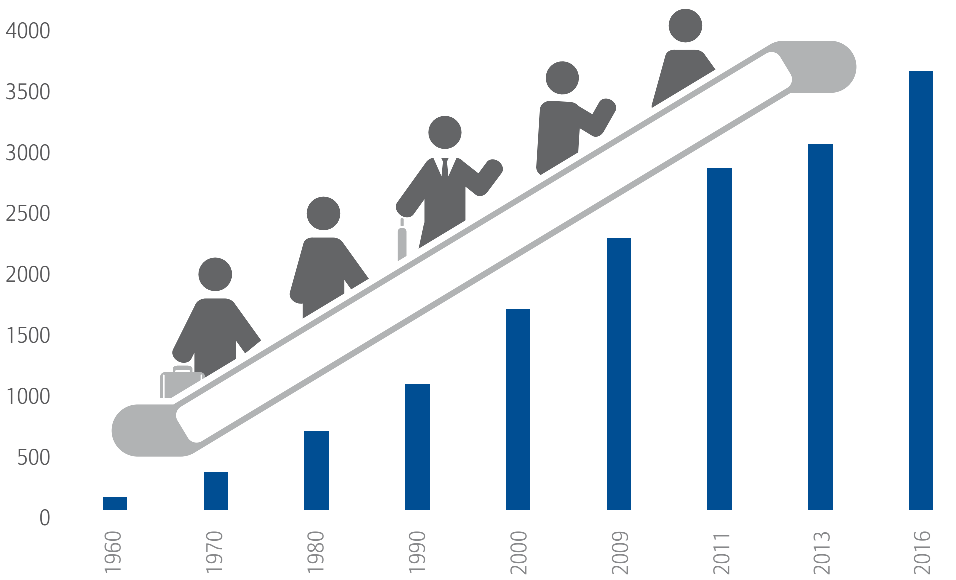
Sources: ICAO State of Global Aviation Safety, Embry-Riddle University, Allianz Global Corporate & Specialty

This table reflects the aircraft accident rates worldwide for the past decade per one million departures.

Passenger growth continues

While the worldwide global accident rate has hovered around four accidents per one million departures the number of departures is increasing resulting in an overall increase in the number of accidents. The worldwide growth of passenger travel has tripled over the past five decades. According to the IATA and the International Civil Aviation Organization (ICAO) the number of passengers flown worldwide for each year from 1953 through 2013, has increased in every single year with the exception of three years surrounding the terrorist hijacking of September 2001[6].

Global passenger numbers on the move (millions)



Sources: IATA Airline Industry Forecast 2012-2016
Graphic: Allianz Global Corporate & Specialty

Advances in science and technology have played a major role in improving safety. Aircraft structures and engines are more reliable.

Last year, the aviation industry flew three billion passengers – equating to eight million per day - and IATA projects that number will increase by 28% to 3.6 billion by 2016[7].

Yet despite such robust growth, the aviation industry has been able to maintain its reputation in safety. Fewer passengers are dying in airline accidents. In 2013 the accident rate decreased to 3.2 per one million departures. Recent examples of the survivability of these accidents are the Lion Air crash in Bali on April 13 last year and the Asiana Air crash on July 6.

The aircraft in the Lion Air crash, a Boeing 737-800 current generation aircraft, was placed into service less than 60 days before the crash. The aircraft crashed into the sea on final approach breaking into two parts yet all 108 passengers and crew survived. Indonesian authorities blamed poor pilot training for the crash. Meanwhile, the Asiana crash at San Francisco involved a Boeing 777-200ER which had been delivered to Asiana in 2006. This aircraft struck a seawall, shearing off the landing gear, tail and engines, and making a 330 degree turn in the air before coming to rest 2,400ft past the impact point. There were 307 passengers on board and only two (three in total) were killed as a direct result of the crash (*see page 39 for the safety implications of this incident*).

Most importantly, safety continues to be improved. Most of the developing countries throughout the world have improved their safety statistics as the industry in general has adopted a much more proactive approach.

Advances in science and technology have also played a major role. Aircraft structures and engines are more reliable and engine systems have been constantly improved. Engine manufacturers have almost eliminated the chances of an engine failure. Radio and avionics are extremely precise and systems integration provides extra information and backup. Current navigation systems have the capability to determine an aircraft's position to the thousandth of a mile. Meanwhile, aircraft data collection devices can record thousands of parameters, increasing the understanding of operations and accidents.

Improvements in science have allowed the industry to better understand how human factors can affect safety. Pilot fatigue, pilot training, crew resource management, and other factors have become increasingly relevant. A better understanding of the system and its parts has resulted in improvement in manufacturing processes, aircraft operations, pilot training, industry culture and government regulation.

Accident rate analysis

Examining accident rates by generation, aircraft type, region and phase of flight. Is there really such a thing as a safest seat?

The age of modern air travel commenced after World War II, particularly in North America, where there was a boom in aviation, both private and commercial, as thousands of pilots were released from military service and many inexpensive war-surplus transport aircraft became available.

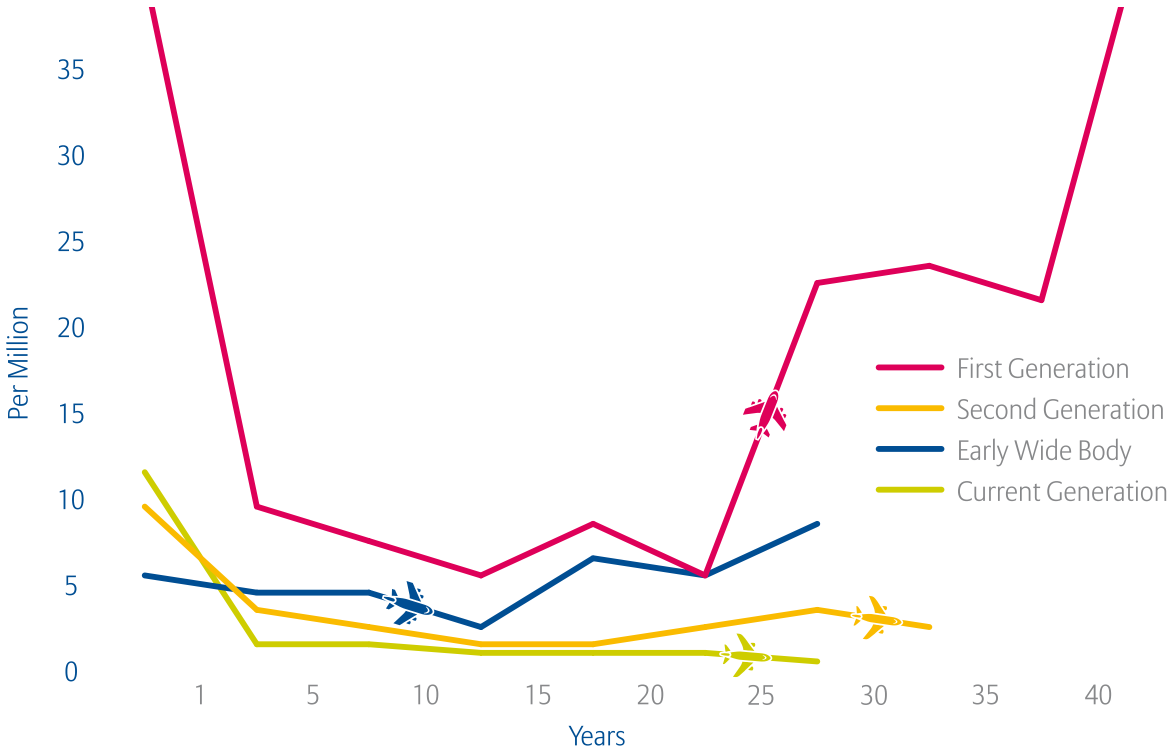
Since the beginning of this era the aviation industry has experienced large growth: aircraft have become larger, more people have flown, and more cargo has been transported by air.

The introduction of the first commercial jet engine aircraft, the De Havilland Comet[8] in 1952 may have signaled the beginning of a new era in aviation industry and air travel but within two years all Comet 1s were permanently grounded as four of the 21 aircraft had been destroyed by design failures.

Six years later in 1958, Boeing introduced its jet airliner the Boeing 707, production of which continued for 31 years. There were 1,010 civilian Boeing 707s produced and during the first five years of operation there were nine fatal accidents[9]. Over the life span of the aircraft there were just 74 fatal crashes, which is a fatality rate of one death per 4.2 million departures[10].

The world's commercial aircraft fleet totaled less than 3,000 in 1960 with the majority of airlines flying piston-driven aircraft. These aircraft were manufactured by Douglas, Lockheed, Convair, and Vickers and are often referred to as the first generation of commercial aircraft. These aircraft experienced an accident rate over the first 10 years of their life of 27.2 accidents per 1 million departures.

Accident Rates Jet Aircraft by Generation per 1 Million departures



First generation of jet aircraft 1952-1966. Second generation 1967 -1974. Current generation 1974 - forward.

Early wide body aircraft (First generation) entered service in 1971 and were produced until 1989. First generation jets were Comet, Caravelle, Douglas DC8, Boeing 707.

Graphic: Allianz Global Corporate & Specialty

> "Aviation accidents are usually the outcome of several factors happening simultaneously or concurrently. Maintenance issues, weather, and other factors may play a role, but more often than not, human behavior, and behavior in the cockpit, plays some role in how and why accidents take place."
>
> Joe Strickland, Global Head of Aviation, Americas, AGCS

The graph on page 14 indicates the accident rate over the life span of an aircraft by generation. Historically, aircraft experience a higher failure/accident rate when they are first introduced and at the end of their designed life span.

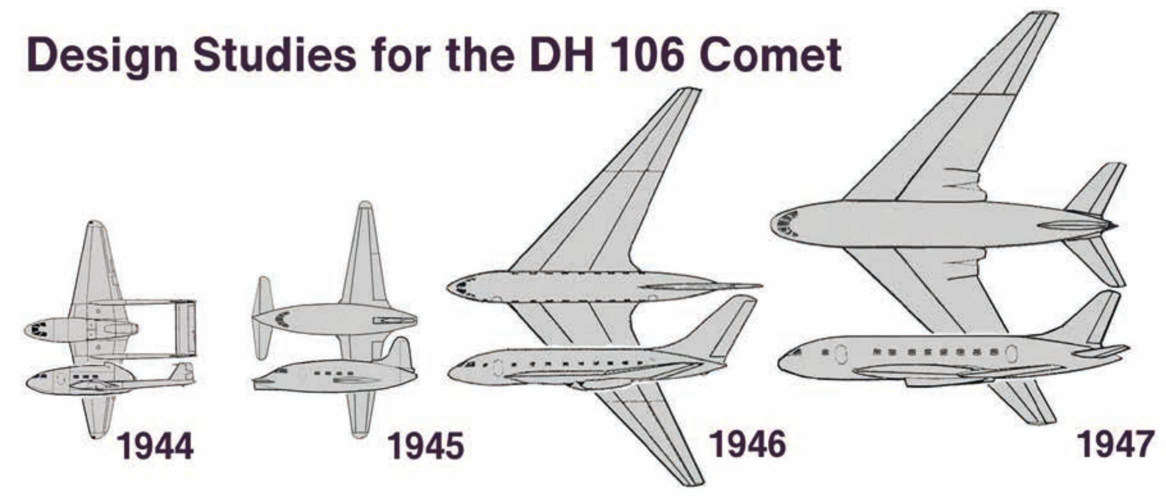
The second generation of airliners entered service in the latter part of the 1960s and early 1970s and include such aircraft as the Boeing 727, British Aircraft Corporation 1-11, and the DC-9.

This generation experienced an improved accident rate of 2.8 accidents per one million departures. The second generation aircraft were equipped with similar turbofan engines to the first generation aircraft but the manufacturers used new techniques to match the engine to the various structures and payloads.

To date, the 727 fleet has carried over four billion passengers worldwide while being involved in 100 fatal accidents[11]. The chance of becoming a fatality on the 727 was .70 in a million[12].

The next generation of aircraft is referred to as Early wide body. These aircraft were the first with two aisles and three sections of seating abreast on the Lockheed L-1011, McDonnell Douglas DC-10, or the Boeing 747. These aircraft recorded an accident rate of 5.3 accidents per million departures, and were involved in 53 accidents from 1992 through 2001[13].

The current generation of aircraft, which includes the Airbus 300, 310, 330, 340, Boeing 737 – 400, 747, 757, 767, 777, 787, and the McDonnell Douglas MD-80-90 series has an accident rate of 1.5 accidents per 1 million departures[14]. The worldwide jet aircraft fleet averaged an annual growth rate of 4.7% between 1971 and 2005, regardless of global crises, and is expected to grow at a rate of 3.6% over the next decade[15]. Today; more than 24,000 aircraft operate in ICAO airspace alone, compared to 20,000 in 2001[16].



The introduction of the first commercial jet engine aircraft, the De Havilland Comet signaled the beginning of a new era in air travel.
Photo: Wikimedia Commons

Regional Fleets by generations and size

25 years

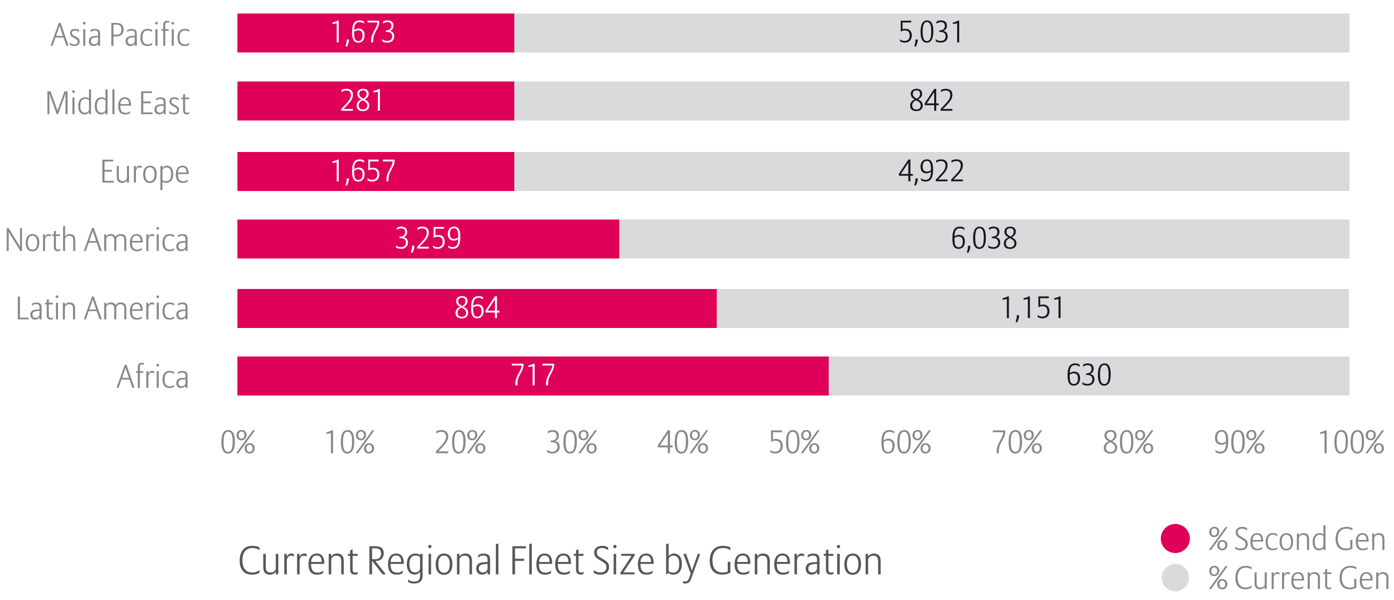
Average lifespan of typical commercial aircraft

The commercial lifespan of an aircraft is typically determined by the number of cycles on an aircraft, flight hours, and other factors. A cycle is typically defined as one single flight of an aircraft, including takeoff, pressurizing the cabin, and landing. The higher the frequency of cycles, or shorter flight segments of an aircraft will typically shorten the lifespan of that aircraft. Each aircraft manufacturer usually estimates the life expectancy of each aircraft[17].

From established and projected trends, the average lifespan of a typical commercial aircraft can be projected to be about 25 years[18].

Taking this into account current regional fleet sizes were collected and divided into two groups. The first group consisted of aircraft types in production since 1990 and is considered to be the current generation of aircraft. They are the newest aircraft and are still under the projected life expectancy. The second group consisted of all aircraft in production since 1970 but prior to 1990. A majority of these aircraft are close to the average life expectancy or have already passed it. This group is considered to be the second generation of aircraft.

Active regional fleets were analyzed for size and generation breakdown. The regional active fleet sizes were current as of May 1, 2013 and excluded any Russian-built aircraft in addition to aircraft considered on order, on option, or stored. The analysis resulted in 27,065 active aircraft worldwide with 68.8% of aircraft being classified as current generation aircraft[19]. The table below shows the current regional fleet size breakdown as a function of aircraft generation.



Current Regional Fleet Size by Generation

Source: Flight Global

Graphic: Allianz Global Corporate & Specialty

Analyzing the results of the regional fleet breakdown, it should be noted that Africa currently uses the highest percentage of second generation aircraft, - over 50% - and has the least number of current generation aircraft. Also, the regions of Asia Pacific, Middle East, and Europe all had almost identical ratios of second generation to current generation aircraft. Upgrading the airline fleet to current generation aircraft is one of the safety initiatives which have lowered the accident rate. The lowest accident rates are held by countries with the modern current generation aircraft.

The aircraft generations *on page 18* indicate the degree of safety built into current generation aircraft. With their advanced instrumentation, automation, and computerized safety management systems current generation aircraft have an excellent reliability rate, as demonstrated by the fact that the number of aviation accidents attributed solely to mechanical failure has decreased markedly over the past 40 years[20]. From 2003 through 2012 there were 75 fatal jet accidents worldwide; only one of those accidents was attributed to failure or malfunction of an aircraft system or component - other than the powerplant, equating to a reliability rate of 98.8%[21]. Current generation aircraft are built with failure-tolerant systems which can maintain a safer environment for aircraft passengers and crew when a failure occurs.

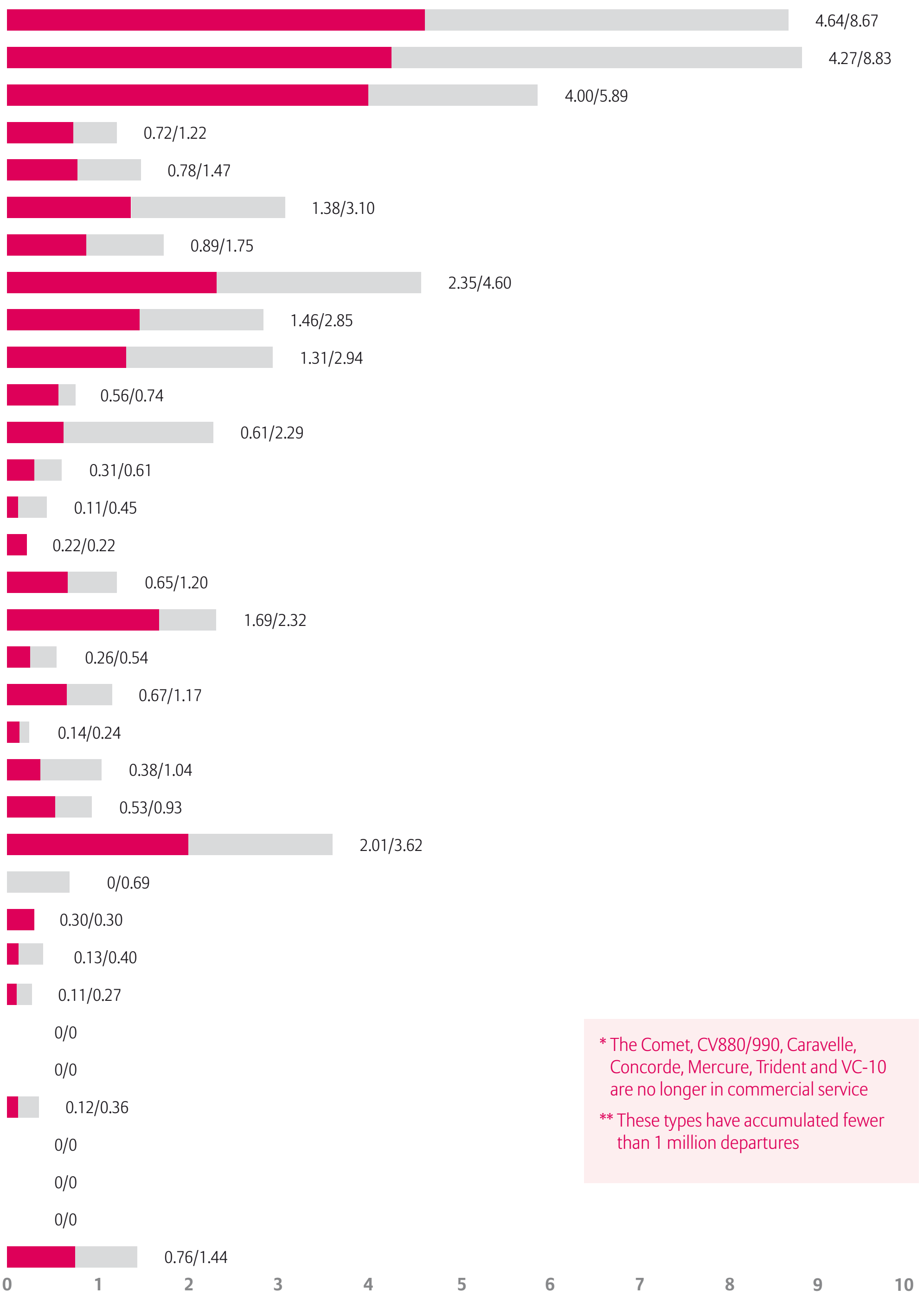
The commercial lifespan of an aircraft is determined by a number of factors including cycles. A cycle is typically defined as one single flight of an aircraft including takeoff, pressurizing the cabin and landing.
Photo: Shutterstock

"The advent of the jet age made air travel much more accessible and since then air safety has continued to improve."
Kevin Smith, Regional Head of Aviation Claims, AGCS

Accident Rates by Airplane Type 1959 - 2013

Hull Loss Accidents - Worldwide Commercial Jet Fleet

Sorted by Year of Introduction	Hull Losses	Hull Losses w/ Fatalities	Hull loss accident rate (per million departures)
*No longer in service	99	53	4.64/8.67
707/720	153	74	4.27/8.83
DC-8	75	51	4.00/5.89
727	94	55	0.72/1.22
DC-9	92	49	0.78/1.47
BAC 1-11	27	12	1.38/3.10
737-100/-200	102	52	0.89/1.75
F-28	43	22	2.35/4.60
747-100/-200/-300/SP	37	19	1.46/2.85
DC-10/MD-10	27	12	1.31/2.94
L-1011	4	3	0.56/0.74
A300	15	4	0.61/2.29
MD-80/-90	27	14	0.31/0.61
767	8	2	0.11/0.45
757	5	5	0.22/0.22
BAe 146, RJ-70/-85/-100	13	7	0.65/1.20
A310	11	8	1.69/2.32
737-300/-400/-500	39	19	0.26/0.54
A300-600	7	4	0.67/1.17
A320/321/319/318	19	11	0.14/0.24
F-100/F-70	11	4	0.38/1.04
747-400	7	4	0.53/0.93
MD-11	9	5	2.01/3.62
A340	2	0	0/0.69
A330	2	2	0.30/0.30
777	3	1	0.13/0.40
737-600/-700/-800/-900	14	6	0.11/0.27
717	0	0	0/0
CRJ-700/-900/-1000	0	0	0/0
EMB-170/-175/-190/-195	3	1	0.12/0.36
**A380	0	0	0/0
**747-8	0	0	0/0
**787	0	0	0/0
Total	948	499	0.76/1.44



Hull loss accident rate – total bar

Hull loss with fatalities accident rate

* The Comet, CV880/990, Caravelle, Concorde, Mercure, Trident and VC-10 are no longer in commercial service

** These types have accumulated fewer than 1 million departures

Source: Boeing Co. Statistical Summary 2013

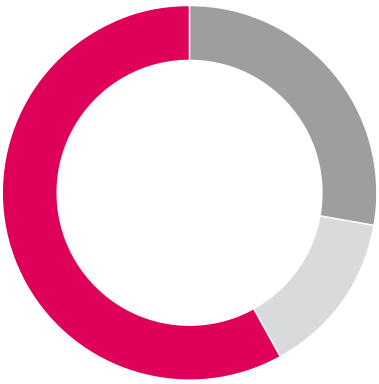
Graphic: Allianz Global Corporate & Specialty

Is one part of the flight safer than another?

According to Boeing every flight can be divided into nine phases – taxi, takeoff, initial climb, climb, cruise, descent, initial approach, final approach, and landing. It is widely accepted that most aircraft accidents happen either on the takeoff or landing phase.

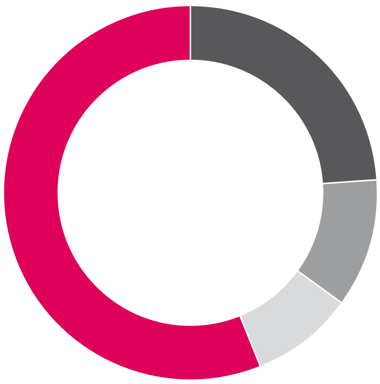
The accidents by phase of flight charts *below* compare the first 40 years of jet aviation with a closer look at the last decade. All phases of flight experienced a reduction in the accident rate through 2003-12. The percentage of fatal accidents during cruise has decreased by 35%. Much of this improvement has been the result of improved navigational and approach instruments, improved cockpit displays and cockpit automation which are incorporated in the current generation of aircraft (*see page 27*).

Accidents by Phase of Flight 1953-93



Takeoff & Climb	28%
Cruise	14%
Descent & Landing	58%

Accidents by Phase of Flight 2003-12



Takeoff & Climb	24%
Taxi, load/unload, parked, tow	11%
Cruise	9%
Descent & Landing	57%

Sources: Boeing Co. Statistical Summary 2013, Embry-Riddle University, Allianz Global Corporate & Specialty

*2003-2012 figures include Taxi/ground incident breakdown.

Note: Percentages may not sum precisely due to numerical rounding.

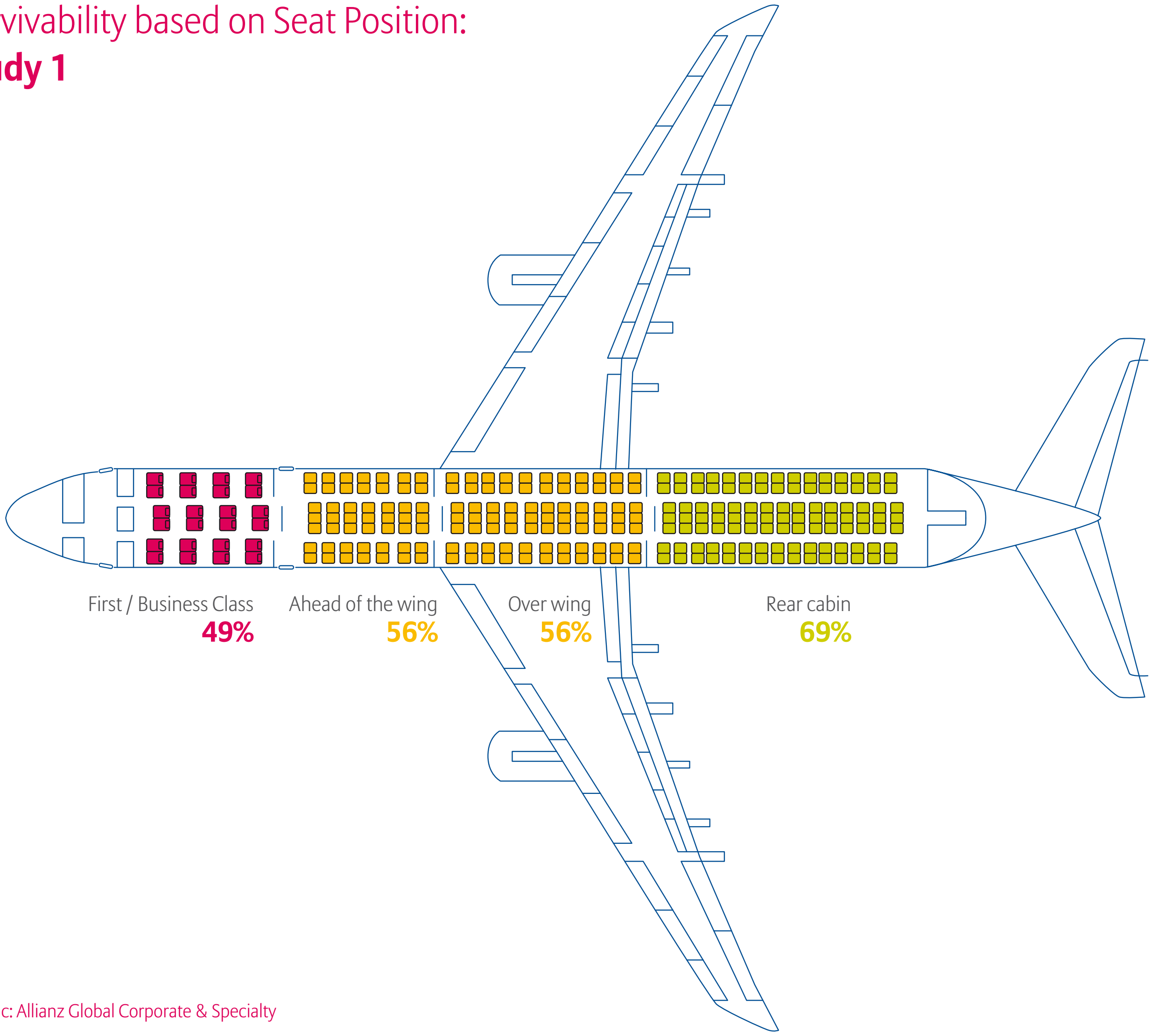
Boeing did not present taxi, load/unload, parked, tow information between 1953-1993

Is there a safest seat onboard the aircraft?

One of the most frequent questions asked in relation to aviation safety is whether there is a safest place to sit in the event of an accident.

There are those who support that sitting in the front of the aircraft is the safest, and those who support that sitting in the back is the safest. In 2007 Popular Mechanics examined every commercial jet crash in US since 1971 which had both survivors and fatalities. Its study suggests the safest seat in the aircraft is in the rear cabin which encompasses the area behind the wings. This section has a 69% survivability rate. Popular Mechanics also examined 20 accidents and calculated the survival rate in each of four sections of the aircraft. Its results found that in 11 of the 20 crashes, passengers in the rear of the aircraft had a better chance of survival. In seven of those 11 crashes favoring the rear of the aircraft they found the rear section was the only section with survivors. In five accidents the first class and business class section fared the best with a 49% survivability rate. In three out of the 20 crashes no one location had an advantage. And in one crash the impact was so severe that seat positions could not be determined. The survivability based on seat position as calculated by Popular Mechanics is shown below.

Survivability based on Seat Position: **Study 1**



Graphic: Allianz Global Corporate & Specialty

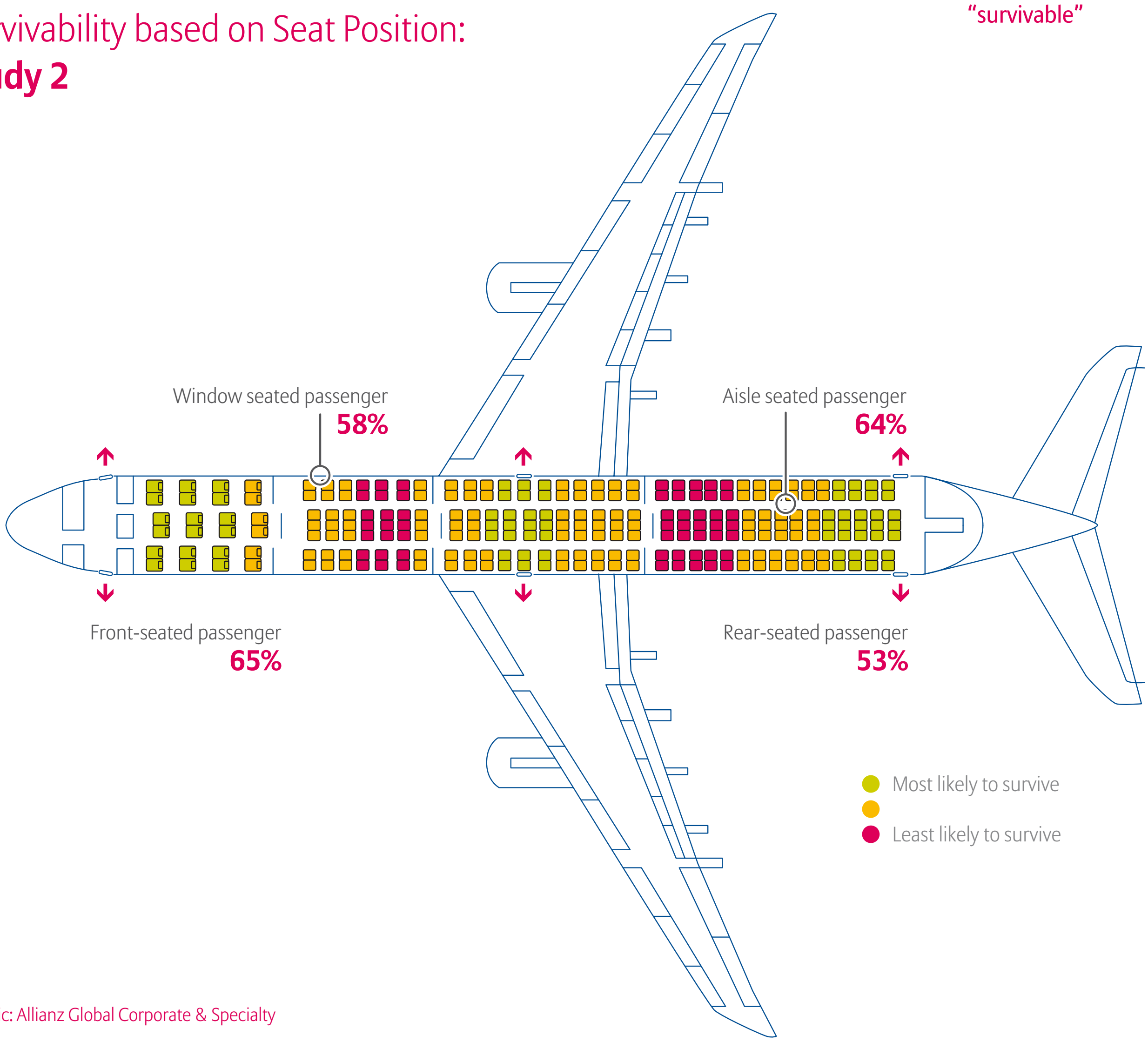
In contrast to the Popular Mechanics study, the University of Greenwich conducted a similar study which resulted in a different conclusion. Greenwich studied 105 airline accidents worldwide, and this study concluded that the safest seat on an aircraft is in the one on the aisle nearest the exit, in the front of the aircraft. This seat has a survivability rate of 65% whereas a passenger seated in the rear section only has a 53% survivability rate. Additionally, any seat in the aisle near an exit offers a greater chance of survivability. When seated more than six rows from an exit "the chances of perishing far outweigh those of surviving"[22]

Aviation experts disagree with both findings yet unanimously agree that there is no safest seat on an aircraft as no two crashes are alike. However, approximately 90% of aircraft accidents are categorized as survivable.

90%

of aircraft accidents are categorized "survivable"

Survivability based on Seat Position: **Study 2**



Graphic: Allianz Global Corporate & Specialty

Regional variations in safety

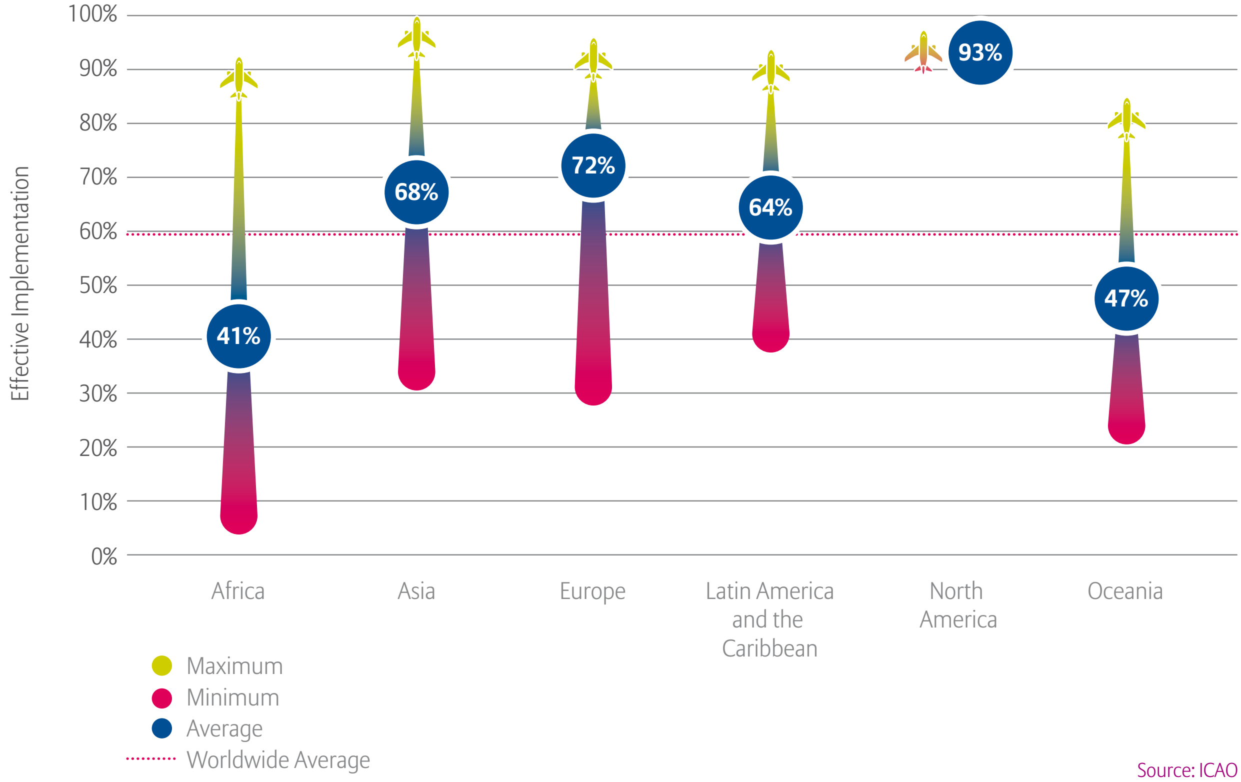
Aviation safety varies across different regions of the world. The state of industrialization of many of the countries is directly related to the safety of that region.

Growing international concern over a lack of aviation system oversight sparked the need for regular auditing of a state's aviation programs. There was growing discrepancy between safety program implementation levels regionally. In 1999 ICAO launched the Universal Safety Oversight Audit Program (USOAP) to perform regular audits of the safety programs of all ICAO member states. The intent of the audits is to evaluate a state's level of oversight implementation and ensure full compliance with the established ICAO standards[23].

The USOAP audit is broken into eight critical elements and rated on a scale of zero to 10 with a rating of 10 being the best possible rating. The eight critical elements are legislation, organization, licensing, operations, airworthiness, accident investigation, air navigation services, and aerodromes[24].

The global audit results published in the ICAO 2013 safety report showed notable effective global implementation rates of 72% for airworthiness, 71% for licensing, 66% for operations, 53% for air navigation services, and 51% for accident investigation[25].

Effective Implementation by Region



Source: ICAO

Graphic: Allianz Global Corporate & Specialty

> "There are regional differences. In some parts of the world human factors, safety awareness and training are a bigger risk than in others. In some developing countries where modern equipment and aircrafts are in use, the pilots and ground crews do not quite have the same level of training as for example in Europe and North America."
>
> **Henning Haagen,** Global Head of Aviation, EMEA and Asia Pacific, AGCS

The USOAP audit results also serve as a proactive measure of safety for each state. The table *below left* displays the minimum, maximum range, and average of each of the world's regions compared with the worldwide average. The United Nations' definition of regions is used in this instance.

As shown – on average – African states trail behind other states in essentially every category. In recent years ICAO has begun to focus in on Africa for its subpar audit results. Africa is forecast to have one of the highest rates of growth of air traffic at over 6% between 2010 and 2015 and air safety is a significant issue as well. More than one-fifth of the world's air accidents occurred in Africa in 2011[26]. Meanwhile, in 2012 African carriers lost 5.3 aircraft per million departures compared to the worldwide rate of 3.2.

In July 2012 the African community agreed to adopt progressive increases to their safety systems. With assistance from ICAO and other states, the African countries agreed to raise their USOAP standards and recommended practices (SARPs) to no less than 60% compliance and resolve all Significant Safety Concerns (SSCs) identified by ICAO. At the time of the publication of the 2013 ICAO Safety Report, six African states had resolved their SSCs and two had raised their USOAP audit results above 60%[27].

Of course regional accident rates at times can be hard to calculate. It has been common practice by many different agencies or states to have varying definitions of an accident. Comparing the accident rate or number of accidents from one state to another is not easy. The criteria for an accident can vary by damage type or severity, degree of injuries or fatalities, location, or operational objectives. Two of the most commonly used criteria are the ICAO and IATA definitions. The main difference between the two is that ICAO includes injury-only accidents by the Annex 13 definition and IATA includes non-scheduled flights[28].

The majority of aircraft accidents occur during takeoff or landing.
Photo: Shutterstock

While some states or regions may report accident rates favorable to them, others are pushing for a global harmonized accident rate. Four years ago the United States Department of Transportation, the Commission of the European Union, IATA, and ICAO all signed a Memorandum of Understanding to create a Global Safety Information Exchange (GSIE).

The GSIE seeks to exchange information that would be useful towards the enhancement of risk reduction and overall safety. The GSIE also created a harmonized accident rate in 2011. From the 2012 accident information there were 99 ICAO accidents and 75 IATA accidents with some overlap between them. The harmonized accident rate per million departures was 2.4 for 2012 whereas, as previously indicated, the ICAO accident criteria had a rate of 3.2 per million departures[29].

Below is a graphic of the breakdown of accidents of scheduled commercial operations that occurred in 2012. The reported accidents were defined strictly as accidents according to the ICAO definition of an accident.

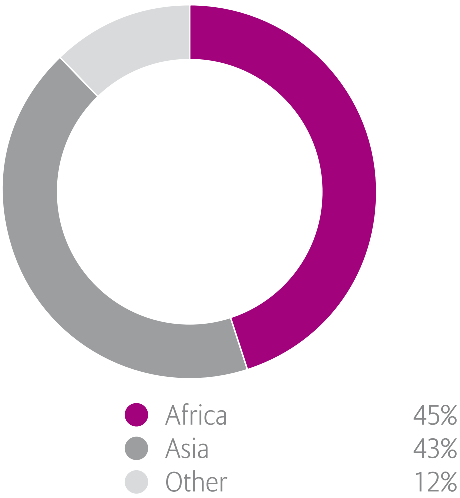
From the accidents in 2012 it is important to notice that Africa accounted for only 5% of the accidents but had the most fatalities of any region (45%) with 167 of the world total of 372. Asia resulted in 23% of the accidents but had 43% of the fatalities with 161. Oceania had no recordable accidents, and with Northern America, had no fatalities.

2012 Accident rate of scheduled commercial operations by region - as % of global total

Region	Accidents	Fatal Accidents	Fatalities
North America	29%	0%	0%
Latin America and Caribbean	12%	11%	1%
Europe	30.5%	33%	11.5%
Africa	5%	22%	45%
Asia	23%	33%	43%
Oceania	0%	0%	0%

Source: ICAO Graphic: Allianz Global Corporate & Specialty

2012 Fatalities By Region



A plane takes off from Sydney airport, Australia. The Oceania region had no recordable commercial accidents in 2012, according to the data set. Photo: Shutterstock

88%

of global aviation fatalities occurred in Africa and Asia

The results from Africa on the USOAP audit, projected traffic growth, and high accident fatality rate are all potential indications of continued poor performance in the near future. In a 2010 ICAO global aviation study the least developed region of Africa had the highest accident rate of 16.8 per million departures. This rate is slightly lower than the US accident rate in 1959 but higher than the rate in the US, Canada, and the EU since 1962.

There is an urgent need to drastically improve safety and safety oversight in Africa in line with the ICAO safety initiatives.

50 years behind
The accident rate in the least developed region of Africa in 2010 was comparable to that of the US, Canada and the EU in 1962. However, the region has made progress in recent years

Aviation safety and oversight needs to improve in many parts of the African continent. Photo: Shutterstock

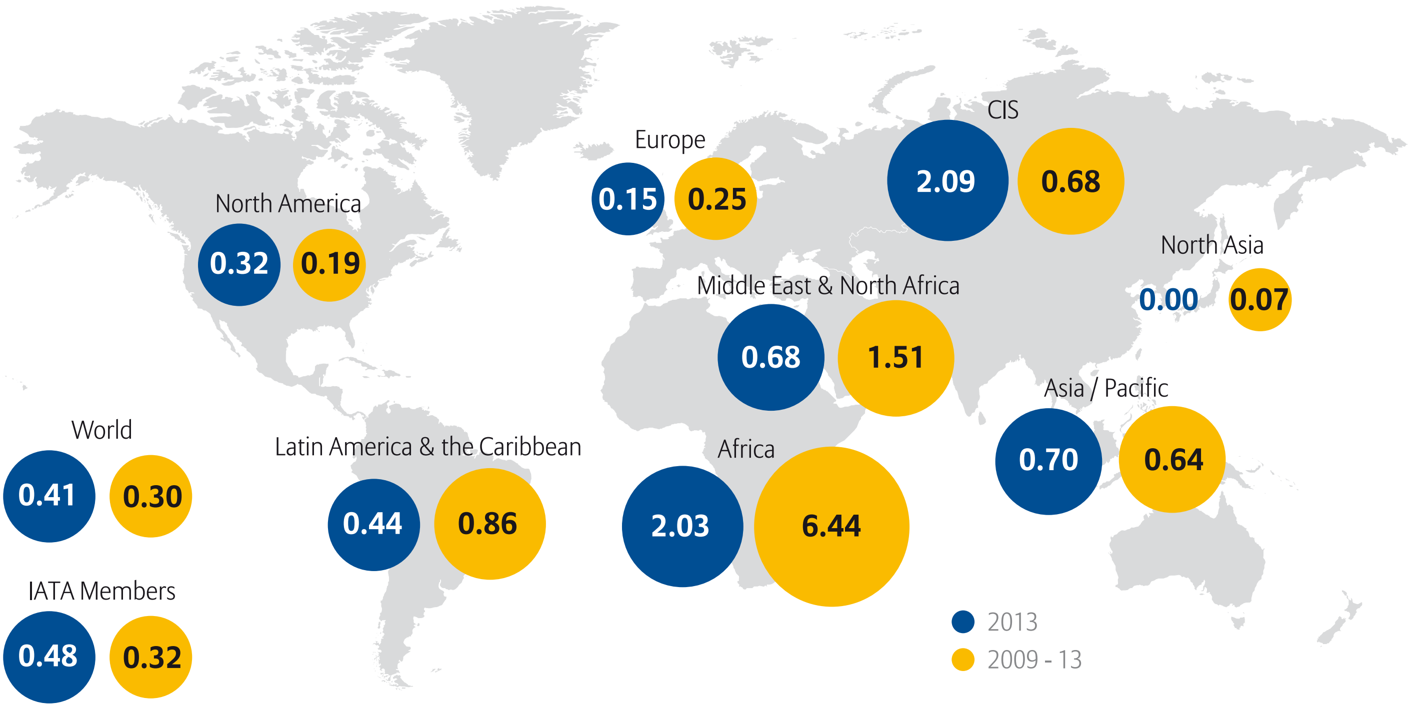
In mitigation, over the past year the Africa region as a whole has seen significant progress in safety. Africa airlines on the IATA IOSA registry had only one western-built jet hull loss last year. In its annual safety review IATA reported that Africa saw an improvement in its safety performance hull loss rate in 2013 as compared to 2012 from 4.55 to 2.03, a 55% improvement. This loss rate also was lower than its five-year average, 2.03 versus 6.44 *(see map page 26)*.

Aviation safety varies across different regions of the world. The state of industrialization of many of the countries is directly related to the safety of that region. In the US, the Federal Aviation Administration (FAA) lists the nations which do not meet minimum international standards for safe flying although they do not identify the specific airlines.

Conversely, the European Union (EU) identifies the foreign airlines which it has banned from flying into the EU because they are considered unsafe. The 2014 European air safety list accounts for 287 known air carriers, whose operations are fully banned in the EU.

Meanwhile, the FAA's list of nations includes 22 not meeting the minimum international standards for aviation. Most of the assessments of foreign civil aviation authorities rely upon self-reporting by the foreign authorities. In some cases, the foreign civil aviation authorities misreport their compliance with the minimum international aviation standards[30].

Western-built Jet Hull Loss Rate by IATA Region Per Million Sectors* (2013 and 2009-2013)



*Flight segment involving a take-off and landing

Definition - A hull loss is an accident in which the aircraft is destroyed or substantially damaged and not subsequently repaired for whatever reason including a financial decision by the owner.

Regional performance - Western-built jet hull loss rates

- The following regions outperformed the global Western-built jet hull loss rate of 0.41: Europe (0.15), North America (0.32), and North Asia (0.00).
- The following regions saw their safety performance improve in 2013 compared to 2012: Africa (from 4.55 to 2.03); Latin America and the Caribbean (from 0.45 to 0.44). North Asia (0.00) and Europe (0.15) were unchanged.
- The following regions saw safety performance decline in 2013 compared to 2012: Asia-Pacific (from 0.50 to 0.70), Commonwealth of Independent States (CIS) (from 0.00 to 2.09); Middle East-North Africa (from 0.00 to 0.68); North America (from 0.00 to 0.32).
- The following regions saw safety performance improve in 2013 relative to the region's five-year average: Africa (2.03 versus 6.44); Europe (0.15 versus 0.25); Latin America and the Caribbean (0.44 versus 0.86); Middle East-North Africa (0.68 versus 1.51) and North Asia (0.00 versus 0.07).
- Latin America and the Caribbean posted a third consecutive year of improvement but the region's rate was slightly higher than the world average.
- CIS had the worst performance (2.09) after having had no Western-built jet hull losses in 2012.

Source: IATA. Graphic: Allianz Global Corporate & Specialty

Aircraft **design** and **technological evolution**

A number of design implementations have had a dramatic impact on aircraft accident rates, helping to significantly reduce risk. Meanwhile, future innovations will aim to further enhance the aviation safety environment.

Much of the improvement in aircraft accident rates has been due to engine improvement. Developments in key technical areas, materials, high by-pass turbine engines, and FADEC (Full Authority Digital Engine Control) have led the improvements. Aircraft propulsion systems have been the means to provide power for flight beginning with the Wright engine which powered the Wright Brothers aircraft. Since then, engine types, horsepower, fuels and reliability have changed and improved dramatically. The reliability of the modern jet engine has provided a level of safety and confidence for the traveling public unmatched by piston-driven engines.

"During the **piston engine era**, if **one engine** was in **trouble**, the flight was in **danger**. With the advent of **jet engines** and **increased power** available to the pilot, the aircraft could **lose an engine** and still **land safely**."

Gary Gardner

Head of Aviation Claims, Americas, AGCS

During the 1950s and early 1960s, the majority of airline engines were reciprocating. These engines were large, noisy, and often shook harshly. Passengers could not help but notice the smoke and often backfires from the engine during startup. What they could not see was the amount of maintenance required to keep these engines in flight-ready conditions. One current measure of reliability is how often the engine must be placed in the shop and the time between overhaul (TBO). TBO is the time period recommended by manufacturers that an engine, airframe, or any other component of an aircraft can operate under average conditions before it should be overhauled.

The piston engines of the 1950s and 1960s period had a TBO of 800 to 1,200 hours depending on the manufacturer. During the past 50 years, the TBO of the major piston-driven engine manufacturers has risen to a range of 1,200 to 2,000 hrs.

A measure of safety which is recognized internationally by ICAO is the rate of Inflight Engine Shutdowns (IFSD). Aircraft wishing to fly across the Atlantic or Pacific Ocean must meet the safety standard of .02 IFSD per 1,000 hours. Today's jet engines have exceeded the safety standard tenfold. Modern turbine engines have an IFSD rate that is 10 times lower than the piston-driven engines of the 1950s. The shutdown rates during the 1950s were .35x10-3 or .35 shutdowns per 1,000 flight hours while the shutdown rates in 2000 were reported at .02x10-3 or .02 shutdowns per 1,000 flight hours. This is one engine shutdown every 500,000 hours[31].

Engine In-flight Shutdown Rate

As aircraft became larger, more power was needed to provide the propulsion, or thrust necessary to provide the airspeed for flight. The development of the gas turbine engine (jet engine) provided the required thrust and reliability for the aircraft of the 1960s and continues to current day. However, today's gas turbine engine reliability is remarkable. The three major engine manufacturers, GE, Pratt and Whitney, and Rolls Royce supply engines for Boeing and Airbus aircraft such as the B737/747/757/767/777 and A320/330 aircraft. These engines usually exceed 16,000 hours of operation before they need to go for an engine shop visit (ESV).

German airline TUIfly recently logged more than 50,000 hours without a shop visit on a GE-CFM engine powering a B737 delivered in 1999. Friedrich Keppler, TUIfly managing director said: "to put this in perspective it is equivalent to driving your car for 16 years with nothing more than oil changes and tune ups; or flying 20 million miles with no engine removals".

Meanwhile, at the Paris Airshow in 2013, Rolls-Royce announced that "a Trent engine travels the equivalent of 14 times to the moon and back before it needs an overhaul."[32]

Aloha Airlines Flight 243: On April 28 1988 it experienced an explosive decompression. Fail-safe design of the aircraft structure allowed the aircraft to continue flying and land with the loss of only one life.

> "Full motion simulator pilot training has contributed to greater safety and avoided accidents. It is possible to create emergency scenarios in the simulator that are not possible in an aircraft such as fires or multiple critical system failures."
>
> **Harold Clark,** Senior Vice President, Underwriting, AGCS

Significant aircraft technology improvements – past, present and future

While commercial aircraft configuration looks outwardly similar, over the past 60 years there have been major improvements in aerodynamics, structures and materials, control systems and propulsion (engine) technology. While not outwardly apparent, aircraft are under constant improvement, thus they are upgraded throughout their life. When new technology is developed, it will be placed into service in the existing fleet if possible. Glass panel instrumentation is an example as it was placed into many existing aircraft. While many of these improvements are discussed throughout this study, a few notable areas are described in the following paragraphs:

Winglets

The upturned portion of the wingtip is known as a winglet. The winglet is a vertical surface designed to operate in the wing tip vortex and provide forward thrust and reduce drag. The winglet acts much like a sail capturing the whirlpool effect "vortices" at the end of the wing.

A benefit of the winglet is that it cuts fuel consumption by 5% to 7%, allowing the aircraft to extend its range with the same fuel load, climb faster to cruising altitude, and provides superior climb and cruise characteristics[33]. Clay Lacy, legendary aviation entrepreneur, has called winglets "the single most significant aerodynamic advancement ever developed for commercial or business aviation."

Aerodynamic and airframe improvements

Innovative manufacturing techniques are being used to reduce drag, decrease aircraft weight and eliminate traditional rivets. Advances in the use of composite material such as carbon fiber which is five times stronger than steel and one third its weight is leading the way in aircraft use. Carbon fiber is also one of the most corrosive-resistant materials available[34]. From a safety perspective; the elimination of corrosion is desirable as untreated corrosion will result in failure. Use of advanced welding techniques such as friction stir and laser beam welding eliminates the need for traditional rivets reducing skin friction (drag) over the airframe.

Airfoil design has advanced dramatically over the past 50 years. Conventional airfoils on the first generation of aircraft have been replaced with laminar flow, wing vortex flow control and divergent trailing edge foils are under consideration. The basic purpose of these foils has been to lower stall speed, increase cruising speed, decrease drag and increase lift. The airfoil on today's commercial airliners is designed for a crack-free structural life of 60,000 hours with a 94% probability of attaining that design[35].

The second generation aircraft and early wide-bodied planes only had about 12% of composite or advanced materials in the airframe. The Boeing 787 and the Airbus A350 feature up to 70% advanced materials and composites. This will result in a 15% weight savings for the aircraft[36].

Fail-Safe Design Criteria

Fail-Safe design is fundamental in the manufacturing and certification process of all aircraft. The FAA Fail-Safe design concept incorporates airworthiness standards which are "based on, and incorporate, the objectives, and principles or techniques, which considers the effects of failures and combinations of failures in defining a safe design."

The following basic objective pertaining to failures applies: in any system or subsystem, the failure of any single element, component, or connection during any one flight (brake release through ground deceleration to stop) should be assumed, regardless of its probability. Such single failures should not prevent continued safe flight and landing, or significantly reduce the capability of the airplane or the ability of the crew to cope with the resulting failure conditions.[37]

Current generation aircraft have many fail-safe systems built into the aircraft. The structure of an aircraft (such as the fuselage and wings) must show that a catastrophic failure due to corrosion, minor damage, or manufacturing defect will not result in the aircraft being unable to fly. An example of this fail-safe design occurred on Aloha Airlines Flight 243 on April 28 1988. While flying at over 300 miles per hour and at 24,000 feet, a Boeing 737 experienced an explosive decompression. A failure of the aluminum skin of the airplane resulted in a loss of many of the panels on the aircraft. The fail-safe design of the aircraft structure allowed the aircraft to continue flying and land with the loss of only one life[38].

Seating improvements

Aviation safety improvements inside the passenger seating area have helped to decrease the injuries suffered by passengers. Aircraft manufacturers use accident and injury data from previous accidents to develop safer more survivable aircraft. Seat design has been improved from being able to withstand a static force six times the force of gravity (a 6g seat) in the 1950s to a 16g seat today. Seat backs and seat back trays have been modified and improved to provide protection from head injuries[39].

Floor lighting

In 1986, the US commercial fleet was retrofitted with floor proximity lighting, marking the completion of a two-year compliance schedule.

The FAA determined that floor lighting could improve the evacuation rate by 20% under certain conditions[40]. Most US commercial airplanes have numerous FAA-required features – such as floor path emergency lighting, fire-resistant seat cushions, low heat and smoke release cabin materials, and improved cabin insulation – to give passengers and crew enough time to make a speedy evacuation. As aircraft became larger, government regulators realized the importance of evacuating the aircraft as quickly as possible. Mandated evacuation times remain at 90 seconds, regardless of the size of aircraft. Evacuation slide deployment times continue to improve. In 1963 the evacuation slides deployed and inflated within 18 to 24 seconds, by the 1990s that time had been reduced to 10 seconds and they must be capable of supporting 60 persons per minute per slide lane.

> "In the past, system design differences between aircraft may have contributed to accidents, due to pilot confusion based on habits."
>
> **Harold Clark,** Senior Vice President, Underwriting, AGCS

Aircraft control surface movement

Fly-By-Wire (FBW) has become the standard for controlling aircraft flight control surfaces. The pilot's yoke/side stick is much like a gaming joystick. Movement of the stick sends an electronic signal to a hydraulic servo actuator near the control surface which will then pump hydraulic fluid to the control surface. The control surface is moved according to the movement of the side stick/ yoke. As a safety precaution, the electrical signal is run through the onboard flight computer to prevent over controlling the aircraft beyond its design limits.

Improvements to cockpit instrumentation and displays

Cockpit instruments include engine and airframe control instruments, flight instruments, and navigation instruments. They are used by the flight crew to monitor the aircraft systems, such as engines, hydraulics, and to maintain aircraft controllability, especially when weather limits pilots' visibility. Flight and navigation instruments allow the pilot to fly the pre-determined route for the flight and approach to the runway.

Advancements in technology throughout the years have allowed cockpit instruments not only to be more precise and reliable, but have also largely improved the pilot-instrument interface.

In the beginning of the commercial jet aircraft era, pilots had round-dial instruments. Flight instruments such as the artificial horizon, airspeed indicator, and the altitude indicator were all mechanic links and not as precise as today. For navigation, pilots would rely on their magnetic compass and instruments with needles pointing the direction of a ground-based station emitting radio signals. Pilots would create a mental picture of what they were flying over and to where they were going. These navigation instruments could suffer interference from several sources, such as any radio signal, aircraft systems or even thunder.

Nowadays, pilots still form a mental picture of their flight, however they have new instruments to help them do so. With the introduction of Global Positioning System (GPS) as the primary mean of navigation, pilots have new information available, such as improved aircraft position in relation to terrain, airports, ground-based navigation stations, GPS fix, and others.

50
times less

Chance of controlled flight into terrain in Western Europe/ North America since 1991 following introduction of EGPWS

With the use of digital displays, or glass cockpit, this new information can be displayed in a screen over a moving map, creating that mental picture. Other new technologies, such as Automatic Dependent Surveillance – Broadcast (ADS-B) and Enhanced Ground Proximity Warning System (EGPWS), can also be incorporated to the glass cockpit technology. ADS-B uses GPS to determine the aircraft position in relation to other aircraft. This system can also generate visual and aural alerts in case one aircraft gets too close to another one. ADS-B antennas on the ground can also receive information from the position of aircraft. In fact, air traffic control radars now incorporate ADS-B feed. EGPWS uses a terrain database, the GPS aircraft position, and radar altimeters to alert the crew of inadequate proximity to terrain.

Previous GPW systems suffered from the lack of being able to "look ahead". They could only look down. When a pilot approached steeply rising terrain the warning from the GPWS could be too late if the slope was severe. EGPWS provides a look ahead feature based on a number of inputs and displays the aircraft's position and altitude on a moving map display of the surrounding terrain.

If the aircraft approaches too close to the terrain an audible alert will sound. The enhanced ground-proximity warning system is regarded by some as the greatest advance in safety since the jet engine[41].

As a result of EGPWS, the risk of controlled flight into terrain is now 50 times less in Western Europe and North America than it was in 1991, making this one of the biggest safety success stories in the history of aviation[42].

Heads up displays (HUDs) are another cockpit instrument to have improved safety. These provide primary flight instrumentation as well as navigational aids displayed on the HUDs' transparent screen in the pilot's forward field of vision. It displays the majority of the available information in the flight computer without the pilot having to continuously look outside (heads up) and inside (heads down) during the most critical phase of the flight, the approach to landing phase and to a lesser extent the takeoff phase. Use of HUDs can reduce distractions during takeoff and landing by up to 60%[43] and are considered to have had a significant impact on the safety landscape[44].

Pilots and controllers texting while flying

It sounds dangerous but actually this is improving safety in the sky. Instead of using radio calls, international aviation agencies are implementing digital messages communication systems for controllers and pilots. Essentially, controller-pilot data link communications (CPDLC) is text messaging for control purposes[45].

Instead of hearing and speaking, typing and reading will be replacing some conversations between pilots and controllers just like cellular phone messaging. The text messages, or control instructions will be entered by controllers. The message is then routed through ground or satellite communication systems into the cockpit displays, where pilots can respond by a click of a button. It will also allow pilots to make requests to controllers in a seamless manner.

By providing pilots a way to physically see the command, this system will avoid some of the miscommunication errors that can lead to accidents. "If you look at a lot of accidents and incidents, you see multiple events. This is an opportunity to eliminate one of them. You're eliminating a source of potential error," said Sid Koslow, chief technology officer for Nav Canada.

In Europe, CPDLC is steadily expanding to all users of air communications. Airlines have previously been mandated to be equipped for CPDLC by 2015.

Eurocontrol envisions an 8% capacity increase since controllers' workload will reduce by 16%. Honeywell, a CPDLC supplier, predicts capacity increase of 11% when 75% of aircraft are equipped with CPDLC. That also equates to a 22% reduction in controller workload.

Electronic Flight Bags – moving towards the paperless plane

As personal computing technology has become smaller and more powerful smaller handheld devices now contain more computer processing power than the laptops of just a decade ago. These personal devices are now capable of storing thousands of pages of information. Devices used for flight operations are referred to as electronic flight bags (EFB) or electronic kit bags.

These are portable systems, either modular or stand-alone, and are required to be accessible to the flight crew without the use of tools to connect or remove from the aircraft flight deck[46].

Today's portable EFBs, are limited to read-only interaction with aircraft avionics systems. That is, EFBs can receive information from the aircraft, but not transmit information. The EFB is designed to replace the pilot's carry-on kitbag which is a bag full of airway charts, airport maps, company operations manuals, aircraft operating manuals, checklists, logbooks and numerous other paper documents required by regulators. Aviation regulations require that each pilot carry a complete set of these manuals and checklists. The pilot's paper kitbag weighs approximately 35 pounds (16kg).

Crews can access electronic documentation of the above items as well as data -linked advanced weather graphics without having to shuffle through numerous paper documents. During flight it has been common for the pilots to have a number of these different paper documents open and spread out on the flight deck. If these documents have not been secure they have slid around and off the tables and glare shields on takeoff and landings[47]. The portable EFB can become both a data display and data input device in the cockpit.

A problem faced by pilots and all airlines is timely distribution of updated aeronautical charts, approach plates, airport diagrams, and similar manuals and information. Through the use of EFBs the airlines and pilots have observed increased efficiency in the reduction and elimination of the paper process as well as reducing cockpit clutter and document handling.

In short, an EFB offers improved safety and decreases a pilot's workload. It also increases familiarity with each airport's layout, enhances taxi situational awareness, and reduces the probability of runway incursions. It also helps ensure the appropriate takeoff and landing speeds based on runway conditions.

Previously, anecdotal evidence from pilots has indicated that there have been occasions when they have not had the latest charts with them during flights.

Meanwhile, taxiing on the airfield has been a reoccurring problem over the past 60 years. Construction, visibility issues, unfamiliarity with the airport and similar issues can occur on a daily basis. The use of an EFB with a moving map display showing the location of the aircraft at the airport may help to reduce incidents and accidents such as the one involving Comair flight 5191 at Lexington Blue Grass airport in 2006. The plane crashed after taking off from the wrong runway, killing 49 people; only the first officer survived.[48].

35 pounds

weight of pilot's paper kitbag (16kg)

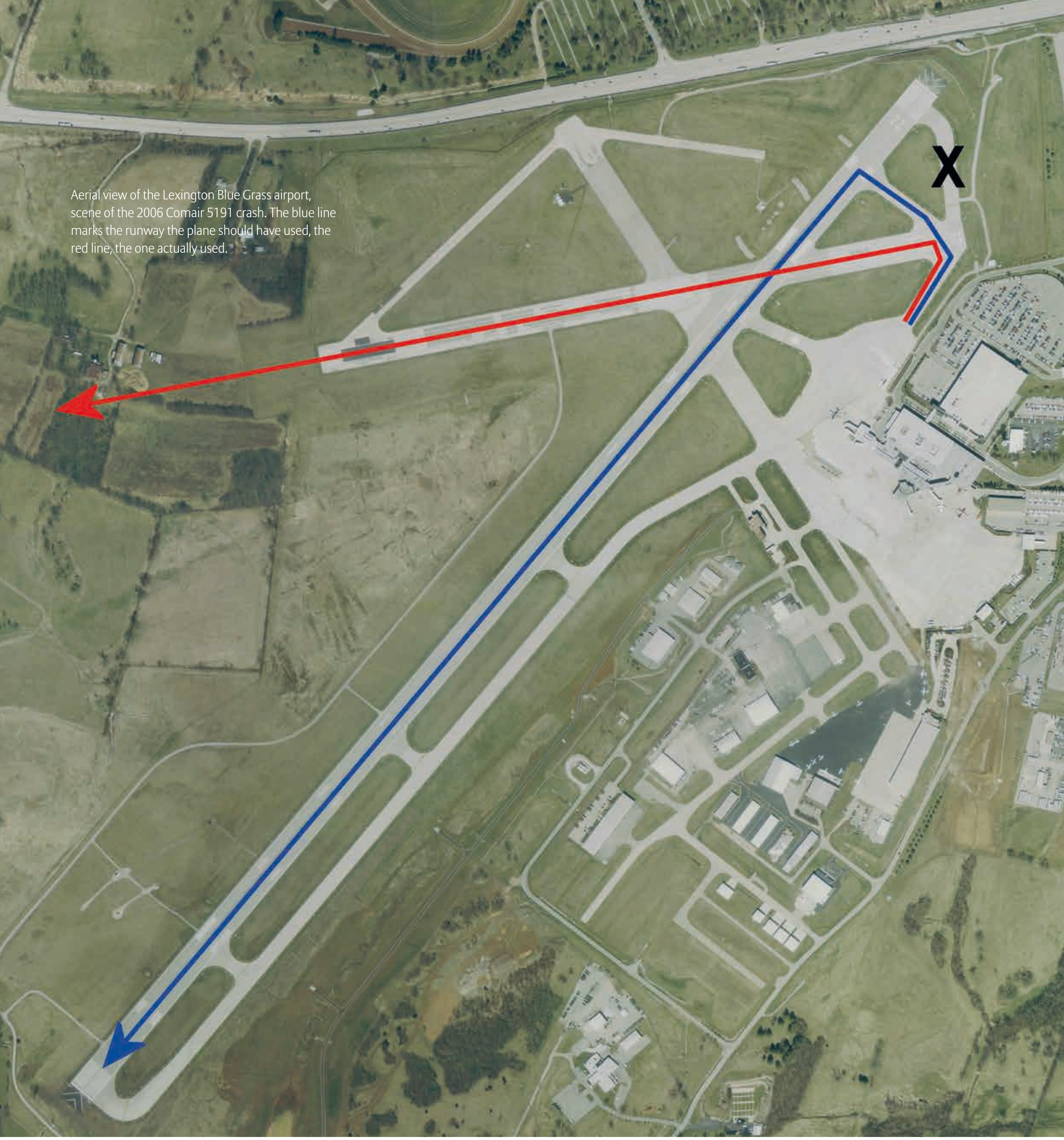
Increasing Need for Flight Data Monitoring Systems

There is a growing need for operators to collect statistical data in the quest to increase safety with the industry needing to improve both its collection of data and its analysis of where it is going wrong.

In the general aviation market, some corporate flight departments are already installing flight data monitoring systems.

There are two ways to look at data that comes out of an aircraft, whether it's a jetliner or a general aviation aircraft. You can review data in retrospect to see what went wrong and train to prevent it from happening again. Secondly, you can spot trends in areas where it didn't lead to an accident but could in certain circumstances.

Collecting that data has been more of a challenge in the general aviation world but such systems have the potential to allow operators to collect data and use it to promote safety.



Approximate paths at Blue Grass Airport (picture before airport construction done weeks before the crash)

Photo: Wikimedia Commons

"Safety has greatly improved over the past 10 to 15 years with a decline in fatalities of more than 50% in western-built aircraft. A significant contributing factor has been the advance in cockpit technology with fly-by-wire technology protecting the flight envelope."

Sébastien Saillard, Head of Aviation Claims, AGCS

Human factors - in the cockpit

In commercial aviation operations, it is estimated about 70% of fatal accidents are related to human error with pilot fatigue a major contributor. Initiatives such as crew resource management, safety management systems and the automated cockpit have played a part in increasing safety levels but the latter can also pose challenges if training is inadequate.

Pilot fatigue was largely ignored during the first 40 years after the introduction of jet aircraft. In the 1930s, recommendations concerning flight time limitations, suggested layover durations, and aircrew rest periods were developed while the airline was flying piston-driven aircraft. Those limitations have barely changed since then. A safety study published in 2003 analyzed the accident rate of pilots as a function of the amount of time that the pilots spent on duty.

For 10 to 12 hours of duty time the proportion of accidents featuring pilots with this length of duty period is 1.7 times as large as for all pilots.

For pilots with 13 or more hours of duty, the proportion of accidents is over five and a half times as high. 20% of human factor accidents occurred to pilots who had been on duty for 10 or more hours, but only 10% of pilot duty hours occurred during that time[49]. Similar studies confirm these findings. Surveys among pilots in Norway, Sweden, and Denmark show that 71% to 90% of pilots said they made errors due to fatigue, with 50% to 54% saying they had dozed off in the cockpit*.

A UK survey** among British pilots showed that of those pilots who had dozed off in the cockpit, 31% said they had awakened to find the other pilot asleep. A recent UK survey among aero-medical examiners (AMEs, i.e. the doctors who regularly examine pilots) shows that 75% consider that up to 25% of pilots are too tired to fly safely. Moreover, 68% of AMEs believe pilots often fall asleep without realizing.

*Pilot Fatigue Barometer, European Cockpit Association
**British Airlines Pilot Association

"A combination of improved **aviation technology** and **training** have led to a **high level** of **air safety** in the **US** and elsewhere. **However**, this means that a lot of people in the **airline industry** and manufacturers have **not been involved in a major accident**. This **lack of experience** is one of the **biggest problems** in **emergency response preparation**."

Ludovic Arnoux
Global Head of Aviation Risk Consulting, AGCS

In one-third of all reports to the UK Confidential Human Factors Incident Reporting Program pilots attribute incidents, errors or problems to fatigue[50]. Meanwhile, NASA's Aviation Safety Reporting System indicates that 21% of reported aviation incidents are fatigue -related[51]. These studies examining the national accident rate and aviation-specific accidents have shown that working over 13 hours accounts for five percent of all human factor accidents[52].

Performance degradation is most visible in a pilot's decision-making ability, visual/cognitive fixation, memory, endurance, judgment, and reaction times.

Pilots attribute their fatigue to sleep deprivation and displaced biological rhythms associated with rapid time zone transitions, as well as scheduling issues such as consecutive duty periods with inadequate recovery breaks, time pressure, and multiple-leg flight segments.

Despite advancements in the scientific understanding of fatigue, sleep, shift work, and circadian physiology few changes were implemented to address crew rest and fatigue issues until 2010.

ICAO, the European Aviation Safety Agency (EASA) and the FAA proposed new regulations to limit the pilot's crew duty and flying time and increase rest times. The FAA implemented this regulation in 2010. The new rule now limits flight time to a maximum of nine hours and also requires a minimum 10-hour rest period to include eight hours of uninterrupted sleep and 30 consecutive hours free from duty on a weekly basis. These changes represent a 25% reduction in crew duty time and a similar increase in crew rest time. The EU Cockpit Association (ECA) published Flight Time Limitations (FTL) for crew members in July 2008. EU member states must respect these limitations but can apply stricter FTL rules at national level[53]. The Duty Hour maximum per each seven days is 60 hours. The Flight Duty Period is 13 hours per day and the minimum rest period is 12 hours at home station and 10 hours enroute.

It is estimated that fatigue contributes to 20% to 30% of all transport accidents (i.e. air, sea, road, rail). Since, in commercial aviation operations, about 70% of fatal accidents are related to human error*; it can be assumed that the risk of the fatigue of the operating crew contributes about 15% to 20% to the overall accident rate.

These flight time limits will improve the human factor issue of pilot error by approximately 5%. Since about 70% of all aircraft accidents are down to pilot error, a 5% reduction should result in a similar improvement in the accident rate.

*www.eurocockpit.be/pages/fatigue-in-accidents

Meeting to discuss the role of EU FTL legislation in reducing cumulative fatigue in civil aviation T. Akerstedt, R. Mollard, A. Samel, M. Simons, & M. Spencer (2003)

Pilot fatigue was largely ignored during the first 40 years after the introduction of jet air aircraft. Performance degradation is most visible in a pilot's decision-making ability, visual/cognitive fixation, memory, endurance, judgment and reaction times.

Photo: Shutterstock

> “There will always be areas to improve in aviation safety, including the area of human factors. However, we have seen astounding progress in this area over the past 30 years, due to initiatives such as CRM.”
>
> **Joe Strickland**
> Global Head of Aviation, Americas, AGCS

Crew resource management (CRM)

Crew resource management or cockpit resource management (CRM) is a set of training procedures for use in environments where human error can have devastating effects. CRM officially began with a National Transportation Safety Board (NTSB) recommendation made during its investigation of the United Airlines Flight 173 crash in 1978, when a DC-8 crew ran out of fuel over Portland, Oregon while troubleshooting a landing gear problem.

This incident occurred around the same time as investigators discovered that a significant majority of aircraft crashes involved human error rather than failures of equipment or weather. A NASA workshop examining the role of human error in air crashes found that the majority of crew errors consisted of failures in leadership, team coordination and decision-making.

98%

of all flights face one or more “threats”

Used primarily for improving air safety, CRM focuses on interpersonal communication, leadership, and decision-making in the cockpit. CRM can be defined as a management system which makes optimum use of all available resources – equipment, procedures and people – to promote safety and enhance the efficiency of operations.

United Airlines was the first airline to provide CRM training for its cockpit crews in 1981 and since then CRM training concepts have been modified for application to a wide range of activities where people must make dangerous time-critical decisions. These arenas include air traffic control, ship handling, firefighting and medical operating rooms.

While it is difficult to assess how many lives have been saved or crashes averted as a result of CRM training, the impact has been significant. Data from the University of Texas’ Line Operations Safety Audit (LOSA) to assess CRM practices shows that 98% of all flights face one or more threats, with an average of four threats per flight. Errors have also been observed on 82% of all flights with an average of 2.8 per flight. Consistent with the outstanding safety record of commercial aviation, the great majority of errors are well-managed and inconsequential due in large measure to effective CRM practices by crews.

“Threats” - generally defined as events or errors that occur beyond the influence of the line personnel, increase operational complexity, and which must be managed to maintain the margins of safety

“The **link between man** and **machine** must be made in **training** and **later in practice**. When the **pilot is flying his aircraft**, he must **be part of his equipment**. He must feel like he is an **integral part of his machine**.”

Josef Schweighart
Head of Aviation Germany , AGCS

Safety Management Systems (SMS)

A safety management system (SMS) represents a systematic approach to managing safety including the implementation of organizational structures, accountabilities, policies and procedures.

ICAO has recommended that all aviation authorities implement SMS regulatory structures and has provided resources to assist with implementation, including the ICAO Safety Management Manual. Unlike the traditional occupational safety focus of SMS, the ICAO focus is to use SMS for managing aviation safety.

A growing number of flight departments are implementing SMS and it is becoming another key area where pilots can enhance their operations through standardization and best practices. It is important, and it should be seen that a SMS is a path toward safer operations, as has been the case in the maritime industry where the International Maritime Organization has adopted SMS with good effect. All international passenger ships and oil tankers, chemical tankers, gas carriers, bulk carriers and cargo ships of 500 gross tons or more are required to have a SMS.

Successful integration of the all different components of an SMS is key and insurers in particular have a vital role to play in ensuring this occurs.

All international passenger ships are required to have a SMS.
Photo: Wikimedia Commons

Increasing automation - too much of a good thing?

Over the past 60 years technological advancement has played a major role in ensuring that flying today is safer than it has ever been. However, high-profile incidents such as the 2009 crash of an Air France Airbus A330 that stalled and went down in the Atlantic Ocean, killing all 228 aboard and last year's crash of an Asiana Airlines Boeing 777-200ER during an unsuccessful landing in San Francisco have also raised the question of whether airline pilots are increasingly too reliant on automation in the cockpit.

Pilot lapses and automation were implicated in these incidents (*see Asiana investigation box right*) while a recent FAA safety study* suggested commercial airline pilots have become so dependent on automation that poor manual flying skills and a failure to master the latest changes in cockpit technology pose an increasing threat to passengers.

Among the accidents and certain categories of incidents that were examined in the study, roughly two-thirds of the pilots either had difficulty manually flying planes or made mistakes using flight computers.

It is clear that Improvements have to be made, especially to get rid of passivity in the cockpit due to automation. Pilot training needs to be changed to address this issue.

* Operational Use of Flight Path Management Systems, FAA and The Wall Street Journal

"Historically, we have seen that any **new advances** in **technology** help to **improve safety**, as long as the pilots are **properly trained** to use the technology."

Michael Kriebel
General Aviation Head, US, AGCS

"Training has changed and improved, but more focus should be placed on continuous training with pilots flying with and without automation. Basic airmanship and hand flying skills remain essential to safely operate any aircraft in all circumstances and in particular if, for any reason, automation is unavailable."

Sébastien Saillard
Head of Aviation Claims, AGCS

Wreckage from the Air France crash in 2009. Such incidents have raised questions about increasing reliance on automation.
Photo: Wikimedia Commons

Asiana crash ruling

Asiana Flight 214 crashed during an unsuccessful landing in San Francisco in July last year
Photo: Shutterstock

Introduction of automated aircraft control has generally been accepted as having improved aviation safety levels but the head of the US National Transportation Safety Board (NTSB) said it is also creating new opportunities for error at the recent hearing into the crash of Asiana Flight 214 in San Francisco last year.

The NTSB ruled in June 2014 that the flight crew's mismanagement of the approach and inadequate monitoring of airspeed caused the plane to crash, noting there was confusion over whether one of the airliner's key controls was maintaining speed.

The crash occurred because the plane was low and too slow during its landing attempt. Its tail struck a seawall and was ripped off while the rest of plane went sliding down the runway. Three passengers were killed in total and more than 200 were injured in the only fatal passenger airline accident to have occurred in the US in the last five years.

Three experienced pilots were in the cockpit of the 777, which previously had one of the industry's best safety records, while weather conditions were near perfect.

Yet the Asiana flight crew "over-relied on automated systems that they did not fully understand," said Chris Hart, the NTSB's acting chairman.

"In their efforts to compensate for the unreliability of human performance, the designers of automated control systems have unwittingly created opportunities for new error types that can be even more serious than those they were seeking to avoid," Hart added.

Among the other issues raised by the investigation are some that have long concerned aviation officials, including hesitancy by some pilots to abort a landing when things go awry or to challenge a captain's actions.

Sources: NTSB
The Guardian: Asiana airlines crash caused by pilot error and confusion, investigators say

"There have been **tremendous changes** in the **flight training** of pilots in trying to **keep up with** the **technology**. It seems **cockpit technology** is **moving faster** than the **training of pilots.**"

Gary Gardner

Head of Aviation Claims, Americas, AGCS

Human factors - on-the-ground

Ramp accidents can cost airlines $10bn a year in direct and indirect costs with non-compliance with operating procedures a significant contributor to this loss tab. Effective communication needs to be an integral part of ramp guidance.

While aircraft accidents in flight continue to become less frequent, aircraft ground accidents remain problematic. ICAO reports that while the rate of accidents in the air has remained steady, the rate of ground accidents is increasing. Based on data developed by IATA, the Flight Safety Foundation (FSF) estimates that 27,000 ramp accidents and incidents – one per 1,000 departures – occur worldwide every year. About 243,000 people, the majority of which are ramp workers, are injured each year in these accidents and incidents; the injury rate is nine per 1,000 departures[54].

Airport ramp safety has been given much attention recently by a number of safety organizations. In spite of their efforts, and those of air carrier safety departments, damage to aircraft and ground equipment and injury to personnel continue to occur during ramp operations.

Initially, one might expect an even distribution of ramp incidents during arrivals and departures. However, in an Aviation Safety Reporting System (ASRS) study set of incident reports describing equipment damage and personnel injury during ramp operations, the aircraft was making its arrival at the time of the incident in 58% of the reports and its departure in 35% of the reports (another 7% encompass miscellaneous events, such as gate changes, power-outs, etc.)[55]. Different procedures - or lack of procedures - during arrival and departure may account for this disparity.

On arrival, the ramp procedures may be loosely defined. The flight crew is often no longer in contact with air traffic control (ATC), or even with company ramp control, once the aircraft transitions to the company gate area. Further, the flight crew communications with ground crew are likely to be primarily visual (hand signals or guide light systems).

In contrast, departure operations tend to be controlled by procedures and checklists. The flight crew is usually in radio contact with ATC or company ramp control before any aircraft movement begins from the gate. In addition, there is more likely to be verbal communication with the ground crew during the early segments of a departure procedure.

The ramp entry or exit area – the area adjacent to a taxiway and leading to or from a company ramp – was the site of the incident in 18% of the study set. Aircraft operating in this area are usually in communication with, and under the control of, ATC. Another 39% of the incidents occurred at the gate entry or exit area, where taxi lines converge leading into or out of the gate area[56]. In this area, an aircraft is less likely to be in communication with some controlling agency, and may be relying on a company ramp control procedure or ground crew input for guidance. The largest percentage of the incidents, 43%, occurred within the gate stop area, that is, within 20 feet of the nose wheel parking line[57]. At this point, the flight crew is usually relying entirely on ground crew guidance for clearance from obstacles and for final taxi instructions. This guidance is often hand signals from ground crew personnel in the form of an all-clear salute, or signals from parking or guidance light systems mounted on the terminal building.

Not surprisingly, there were more incidents in the gate stop area during arrival (48%) than during departure (31%). A possible explanation is that there are more obstacles to encounter when entering the more congested area next to gates and terminal buildings. It was also noted that there were fewer incidents on the ramp fringe areas during arrival (13%) than during departure (30%)[58]. This may be related to the large number of pushback, power-out, and power-turn procedures occurring during departure operations.

Ramp Incident Distribution – Arrival And Departure

Incidents in The Gate Stop Area:

Source: Aviation Safety Reporting System – Ramp Safety
Graphic: Allianz Global Corporate & Specialty

Ground equipment, and by association, ground personnel, appear to be most vulnerable to damage or injury in ramp operation incidents, accounting for 21% of the incidents after the aircraft was stopped. Ground equipment damage occurred most often in the gate stop area, less so in the gate entry/exit areas, and rarely on the ramp fringe areas.

Ramp congestion, increasing numbers of flights, stringent aircraft scheduling requirements, and efforts to squeeze large jets into gates originally designed for much smaller aircraft contribute to traffic jams and tight quarters on the ramp.

Reporters stated that they were provided with ground personnel for ramp guidance in 64% of the incidents. Marshalers were reported as present in 56% of the incidents, and one or more wing walkers were present in 17% of the incidents[59].

Communication is an integral part of ramp guidance and ineffective communication is at the heart of most ground accidents. Reporters were communicating – verbally, visually, or both – with the ramp guidance personnel in 79% of the incidents. Unfortunately, however, 52% of the reporters stated that the communication with the guidance personnel was poor[60].

Aircraft ground accidents remain problematic.
Photo: Shutterstock

The Ground Accident Prevention Program (GAP)

In 2003, the FSF launched the GAP program in response to the increasing number of ground accidents. The GAP program developed information and products in a practical e-tool format – designed to eliminate accidents and incidents on airport ramps (aprons) and adjacent taxiways, and during the movement of aircraft.

Airport ramps, or aprons, are busy and dangerous places, confined areas in which aircraft, vehicles and people are in constant motion in all types of weather. Turnover among personnel typically is high, quality of training can be inconsistent, and standard operating procedures may even be non-existent or ignored.

In 2007, the GAP program estimated a loss of $5bn as the direct costs of repairing aircraft damaged on the ramp. It included $4bn for the airline industry worldwide and $1bn for corporate aircraft operators[61]. Only a fraction of the losses are covered by insurance. One airline told the FSF that of the 274 accidents that occurred during ramp operations, only one resulted in direct costs that exceeded the deductible limit of its insurance coverage. The average cost of the ramp accidents was $250,000. The airline's deductible limits were typical of the industry: $1m for a widebody airplane, $750,000 for a new narrowbody airplane and $500,000 for an older narrowbody[62].

The $5bn cost estimate helped focus attention on the problem. The monetary losses were being accepted as a cost of doing business and were not seen as stemming from a safety problem on the ramp. However, this initial estimate did not include the indirect costs of personnel injury on the ramp. As the cost model was refined, the combined direct and indirect costs for medical treatment and related factors doubled the initial estimate.

The most recent estimate is that ramp accidents are costing major airlines worldwide $10bn a year in direct and indirect costs[63]. Using IATA activity data initial analyses of GAP data collected to date indicates that contact between airplanes and ground-service equipment – baggage loaders, air bridges, catering vehicles, fuel trucks, etc. – accounts for more than 80% of ramp accidents/incidents.

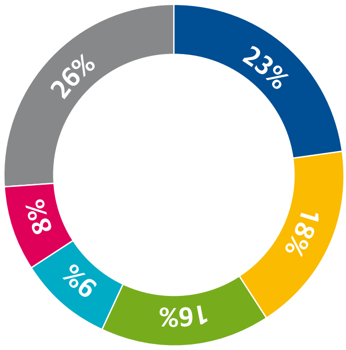
The GAP team notes human factors, particularly non-compliance with standard operating procedures, as a dominant factor in ramp accidents and incidents.

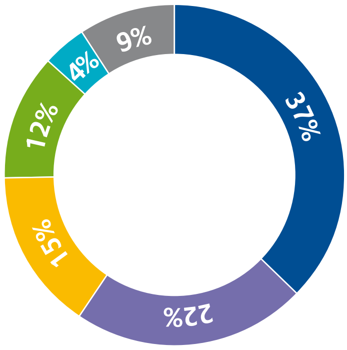
Ineffective communication is at the heart of most ground accidents.
Photo: Shutterstock

On the horizon - risk management challenges

Huge improvements in airline safety are leading to fewer fatal or catastrophic passenger airline losses overall, despite 2014's extraordinary loss activity. However, technology brings its own vulnerabilities with the cost of aviation claims rising, driven by the widespread use of new materials. Meanwhile, the tragic disappearance of Malaysia Airlines flight MH370 poses a number of new issues.

Top Causes of Loss: Aviation Claims (€1m +)





No. of Claims	
Plane crash	23%
Ground handling	18%
Mechanical failure	16%
Hard landing	9%
Damage by foreign object	8%
Other	26%

By value	
Plane crash	37%
Over/undershot runway/taxiway	22%
Ground handling	15%
Mechanical failure	12%
Hard landing	4%
Other	9%

Source: Allianz Global Corporate & Specialty Global Claims Review 2014. *Data based on accident years 2009-2013*

The long term improvement in global airline safety is due to a combination of several positive trends. Aircraft have become more reliable and safer while safety systems have improved enormously - for example, the increasing number of fly-by-wire *(see page 30)* controlled aircraft in operation has had a significant impact. At the same time the standard of training for crew has become notably higher. Improved air traffic control technology and better collision avoidance systems are also having a positive impact. Meanwhile, pilots now have much more live information at their fingertips, including more accurate and up-to-date weather data.

Safety inspections are now far more effective. Aircraft inspections are much more detailed and stringent than in the past and have been quick to incorporate improved technologies. This means problems are increasingly being identified and dealt with long before they become a significant issue.

Another major factor behind the reduction in major losses has been the increased use of recurrent training - additional on-going training that can refresh the skills of pilots and crew, as well as help them prepare for unusual or emergency situations.

This has had a significant impact in reducing accidents, and therefore insurance claims, in both mature and emerging markets.

Indeed, most airline and general aviation insurers now require policyholders to carry out recurrent training and operators typically send their pilots and crews back to school on a regular basis.

Insurance trends

The much-improved safety environment is reflected in the fact that premiums for aviation insurance, which helps to protect the sector against a number of risks, were at their lowest levels for many years, prior to 2014's loss activity.

However, there has been a 50%-plus increase in exposure (ie the potential loss) since the turn of the century, driven by increasing fleet values and more passengers.

Exposures increased from $576bn in 2000 to $896bn*.

This means that if exposure** growth continues at the same rate, we can expect it to break through the $1 trillion barrier within the next five years and possibly even earlier.

* Aon Airline Insurance Outlook 2014

** *The risk exposure refers to the total Average Fleet Values (AFV) which are the average value of an airlines fleet over the annual period of the insurance policy.*

"New aircraft with advanced systems and composites are more and more complex and expensive to repair. Previously, equipment and passenger losses were the main driver of loss activity. Today, compared with the past, there are fewer fatalities or total hull losses due to improved safety, but new types of risk and losses, such as composite repairs, ground equipment damage or the risk of grounding, are additional drivers of exposure."

Henning Haagen
Global Head of Aviation EMEA
and Asia Pacific, AGCS

Photo: Shutterstock

"Improvements in aviation technology, such as the **collision avoidance system** TAWS, have **increased safety** in the **most critical flight phases** such as **approach and landing.**"

Tom Fadden
Underwriting Manager - Airlines, AGCS

Everyday losses increasing

$1trn

Increasing fleet values will push the value of risk exposure past this total in the next few years

While there has been a significant reduction in catastrophic loss events in recent decades, unsurprisingly plane crashes remain the major cause of loss for the aviation sector in terms of number of insurance claims generated (23%) and their subsequent value (37%) *(see charts, page 43)*, with over/undershot runway incidents ranked second according to value. Indeed, plane crashes are the third most expensive cause of loss for businesses behind ship groundings and fire, according to an analysis of more than 11,000 major business claims by AGCS*.

However, it is important to note that almost a fifth (18%) of aviation claims relate to ground handling claims and 16% to mechanical failure, especially when considering everyday (attritional) losses have not improved, reflecting the increasing cost of repairs and the growth of the airline industry, particularly in emerging markets.

Aircraft are now far more complex, employing new materials and technology. On average there are approximately 600,000 parts on an airline-type aircraft and this is resulting in a significant change in claims handling and costs.

For example, the latest generation of aircraft, such as the Airbus A350 XWB and the Boeing 787 Dreamliner are built using composite materials (such as carbon fibers encased in toughened resins). Such materials are more light-weight yet stronger than traditional materials (such as aluminium), but repairs can be comparatively more time-consuming and costly.

Composite repairs require the relevant expert technicians, often in limited supply. As a result, new generation aircraft take more time to assess damage and repair, leading to more down time and more expense.

At the same time, the cost of repairing older aircraft is also increasing. Ageing fleets are more expensive to repair as the availability of parts becomes more problematic.

* Global Claims Review 2014, Allianz Global Corporate & Specialty

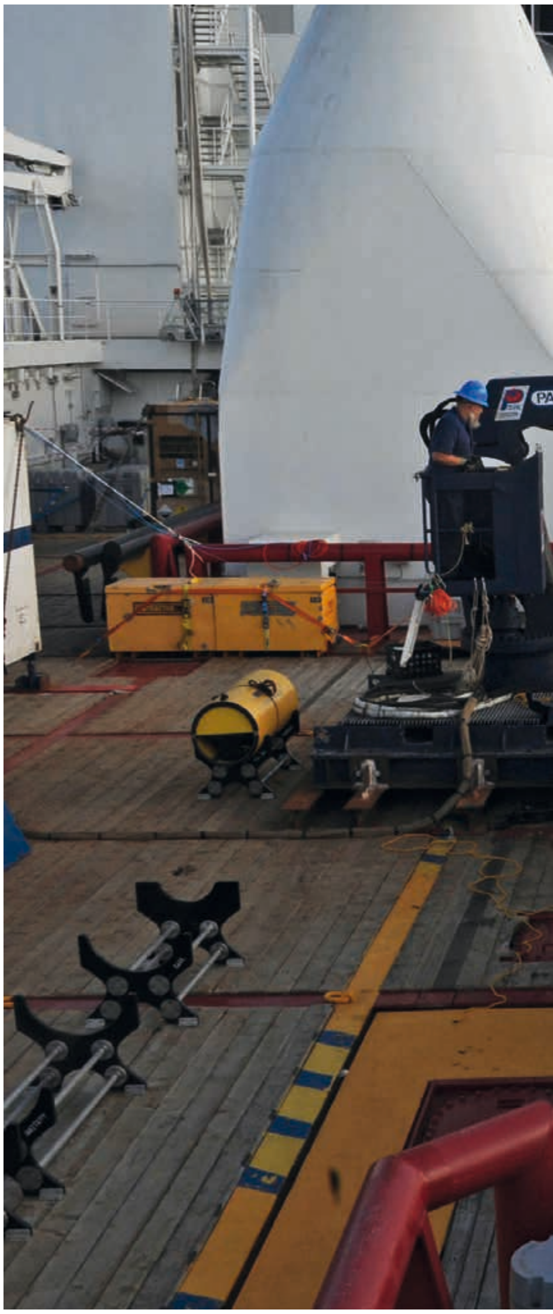
The increasing complexity of aircraft design has other implications for claims costs. For example, manufacturers and Maintenance, Repair and Overhaul (MRO) contractors keep fewer spare parts in stock, while an increasing number of components have to be made to order.

The use of MRO companies is a topical issue for aviation claims. MROs require the consent of manufacturers before carrying out repairs but manufacturers increasingly prefer to carry out repairs themselves.

For major claims it may be appropriate to go with the manufacturer because they are more likely to have the required spares in stock and can work faster. But for standard claims it could be more cost-effective to use an MRO.

Insurers cannot influence the manufacturer's decision on whether to use a MRO which can result in a more expensive claim. This trend is likely to continue, especially with the introduction of more complex new generation aircraft.

The cost of aviation claims has also been rising with more stringent regulation – for example, manufacturers and MROs can no longer use the same approved technician to carry out both the repair and inspections, which leads to yet more additional cost – and the continuing growth of liability litigation.



MH370 – the implications for the aviation sector and safety

Aircraft tracking and traffic management, security, sharing of data and best practices, flight recorders, underwater locating devices and cockpit voice recorders are the major issues for aviation stakeholders following the tragic disappearance of the Malaysia Airlines flight earlier this year.

On March 8, 2014 Malaysia Airlines flight MH370 left Kuala Lumpur bound for Beijing China with 239 passengers and crew on board. An hour later it vanished with the fate of all those aboard the aircraft unknown, triggering a huge international search operation across vast swathes of the Indian Ocean.

The tragic disappearance and loss of the aircraft, for which AGCS acted as the lead reinsurer, has a number of long-term implications for the aviation sector which are already starting to be addressed as investigations into the incident continue.

These issues have been considered by a number of important industry stakeholders since the plane went missing:

Aircraft tracking and security

The International Air Transport Association (IATA)

"The tragedy of MH370 has saddened us all. Something terrible happened on what should have been a routine flight. The airline industry, its stakeholders and regulators are at the beginning of what may be a long journey to unravel this mystery, understand the cause and find ways to ensure that it is not repeated. That is the best way for all of us in aviation to honor the memory of those on board.

"Speculation – of which there has been much – will not make flying any safer. MH370's so-called black box containing the flight data and the cockpit voice recorders are the best hope for learning what happened.

"There are, however, at least two areas of process–not cause–where there are clearly challenges that need to be overcome.

"The first is how we follow aircraft as they move around the globe. In a world where our every move seems to be tracked, there is disbelief both that an aircraft could simply disappear and that the black box is so difficult to find. While some progress has been made since the accident involving Air France 447, we must accelerate our efforts. We cannot have another aircraft simply disappear.

"ICAO has well-established processes to move this forward.

"The aviation industry must and will play a role in supporting ICAO in this effort with a united position. That is why IATA has convened an expert taskforce

An autonomous underwater vehicle is prepared to search for the missing flight in the Indian Ocean.
Photo: Wikimedia Commons

to examine all of the options available for tracking commercial aircraft. The group will weigh considerations of implementation, investment, time and complexity to achieve the desired coverage.

"The second area where action is needed is related to the discovery that stolen passports were used by two passengers. This is a matter of serious concern.

"Intelligence is critical to keeping flying secure. Security is the well-established responsibility of governments. About 60 governments require airlines to provide advanced passenger data. Airlines understand that thorough passenger pre-screening by governments is a necessary security measure. In fact, airlines go to great lengths and expense to provide these governments with reliable data, including passport information. It is vital that the information they use is for its intended purpose, else why collect it?

"Accidents are rare. Each day nearly 100,000 flights take people safely to their destination. That is because the aviation industry and its regulators are never complacent about either safety or security. Even before we know what happened to MH370, we have already begun important work to make a safe industry even safer."

First published June 2014. IATA previously announced the formation of a task force to evaluate options and deliver an industry position related to enhanced aircraft tracking by December 2014.

Air traffic management and sharing of data and best practices

Association of Asia Pacific Airlines (AAPA)

“Around the world, nine million passengers a day take to the skies with the knowledge that air travel is safe, secure and convenient. The aviation industry has established an excellent safety record, due to the collective efforts of industry safety professionals over the years, constantly striving to make flying even safer.

“Over the past decade, as an industry we have been able to demonstrate continuous improvement in aviation safety performance. This can be attributed to regulatory and industry collaborative efforts, including improvements in technology, designs and certification standards applied to aircraft over the years, further enhanced by refinements to operational performance standards and safety training. This explains why 2013 was one of the safest years ever in terms of commercial airline jet fatalities.

“Nevertheless, there is no room for complacency. The recent tragic loss of MH370 remains a mystery, but has again highlighted the challenges of air traffic management in keeping track of more than 30 million flights a year. AAPA is a member of the industry task force led by IATA which is assessing various technologies and operational changes that could support enhanced global surveillance of all commercial aircraft movements.

“Safety requires close cooperation between regulators, airlines and other involved stakeholders; with the sharing of data and best practices, as well as effective consultation processes and communications. AAPA is committed to working with stakeholders and playing a critical role in ensuring that airlines in the region remain vigilant in maintaining the very highest safety standards.”

First published June 2014.

Photo: Shutterstock

Air Traffic Control Tower at JFK Airport in New York. MH370 has highlighted the challenges of air traffic management in keeping track of more than 30 million flights a year.

Flight recorders and underwater locating devices

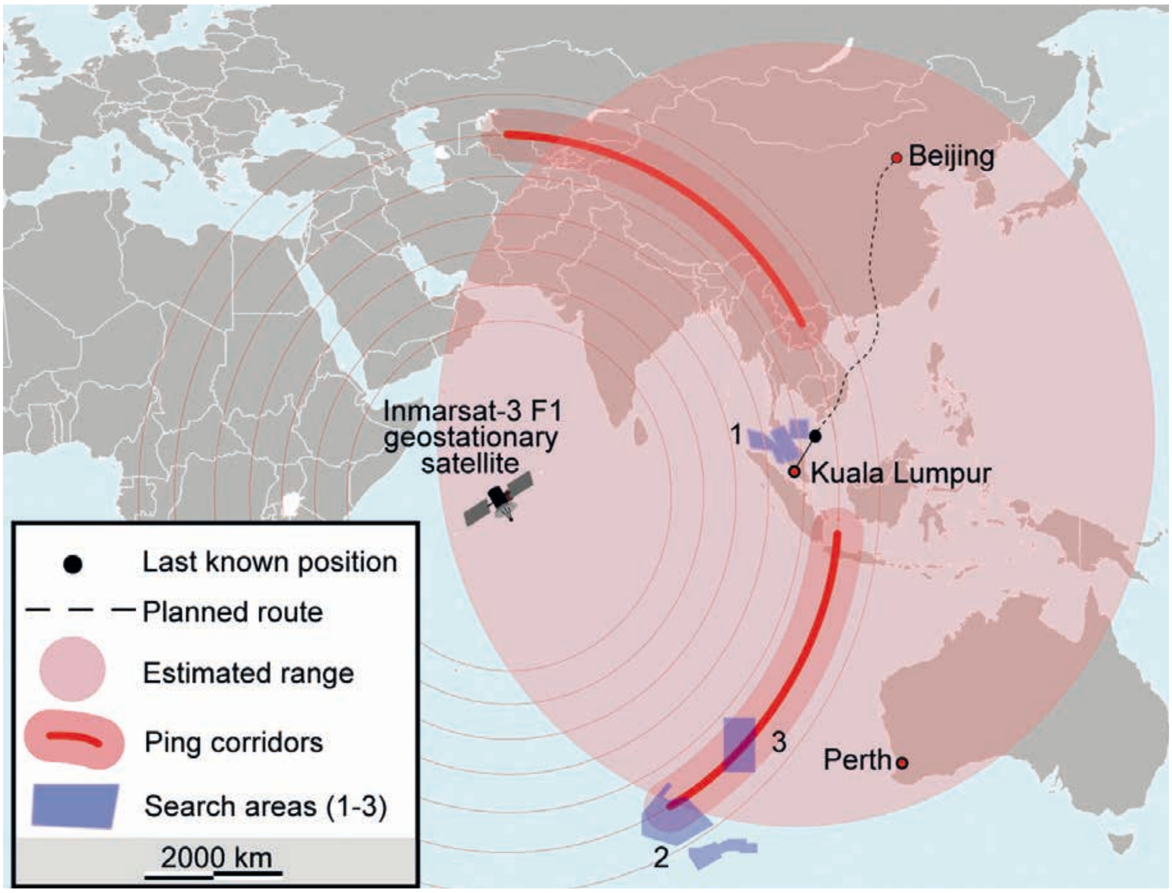
The European Aviation Safety Agency (EASA)

"EASA has announced new proposals for flight recorders and underwater locating devices which aim at facilitating the recovery of an aircraft and of its flight recorders in the unfortunate eventuality of an accident.

"The new EASA requirements include the extension of the transmission time of underwater locating devices (ULD) fitted on flight recorders from 30 days to 90 days. EASA also proposes to equip large airplanes flying over oceans with a new type of ULD that have a longer locating range than the current flight recorders ULDs. Alternatively, aircraft may be equipped with a means to determine the location of an accident within six nautical miles accuracy. In addition, the minimum recording duration of cockpit voice recorders installed on new large airplanes should be increased to 20 hours from two hours today.

"The tragic flight of Malaysia Airlines MH370 demonstrates that safety can never be taken for granted. The proposed changes are expected to increase safety by facilitating the recovery of information by safety investigation authorities."

First published May 2014.



Map of the search area for MH370.
Photo: Wikimedia Commons

Tracking aircraft outside of normal radar range and cockpit voice recorders Embry-Riddle Aeronautical University

"The disappearance of MH370 has ignited a discussion in the aviation community regarding the tracking of aircraft outside of normal radar range. Currently there are a number of areas of the world which are outside of ground-based radar tracking stations and aircraft must periodically report their location to air traffic control.

"A system which is used for communication, both outside and under radar contact, is the aircraft communications, addressing, and reporting system (ACARS).

"This is a digital communications datalink for the transmissions of messages between the aircraft and ground stations. The system uses alpha numeric text messages which are similar to twitter messages sent between smart phones over a cellular phone system. ACARS continues to be improved and is used in many instances to communicate messages such as aircraft status position, technical performance data, abnormal aircraft system status, weather, and also loading and trim information.

"ACARS uses a data link service provider (DSP) who is responsible for the movement of these messages by radio link or by satellite communications between the sender and receiver. The primary DSPs are Aeronautical Radio, Inc. (ARINC) and Societe Internationale de Telecommunications Aeronautiques (SITA). Due to the limited distance of radio transmission, satellite DSP companies have now entered the datalink service provider arena. INMARSAT and IRIDIUM provide worldwide data link capability through the use of satellite communications.

"Both ICAO and IATA are recommending real time global tracking of airliners. Meanwhile, the European Commission (EC) has supported plans to increase the tracking of commercial airliners following a meeting of European Union (EU) transportation ministers. The EC indicated EU aviation safety regulations will be made in 2015 and one of the regulations will make it impossible to disable the tracking system during flight. Only a few airlines rely on existing satellite and aircraft communication systems to provide full-time position information for airliners.

"In an effort to speed up adoption, INMARSAT, whose network tracked the digital pings from MH370, has offered tracking services to the airlines free of charge. Approximately 11,000 current airliners have INMARSAT antennas installed but all are not using the tracking service.

"Meanwhile, additional solutions to improve aircraft accident investigation being considered are; to increase the battery life on the cockpit voice recorder (CVR) and flight data recorder (FDR) from the current 30 days to 90 days, and to increase the recording time on the CVR from two hours to 20 hours.

"A service which INMARSAT is offering is a 'cloud-based black box'. This service would be a quantum leap forward and will allow aircraft to stream real-time data about the aircraft systems which are normally recorded by the on-board black boxes. Having the FDR and the CVR information available without having to find the physical box would eliminate the 'what happened?' issues in aircraft accidents."

> "The good news is the satellite communication landscape has changed and in orbit capacity has grown drastically. This situation opens up opportunities to change minds and technology."
>
> **Ludovic Arnoux**, Global Head of Aviation Risk Consulting, AGCS

The aviation sector faces a host of potential new threats.
Photo: Shutterstock

On the horizon - emerging risk assessment

Determining future threats to operations is key to the aviation sector maintaining its much-improved safety record in future. In addition to the host of potential risks posed by natural hazards, technological advances, human error, war and terrorism, the industry is also having to remain alert to a number of other new challenges.

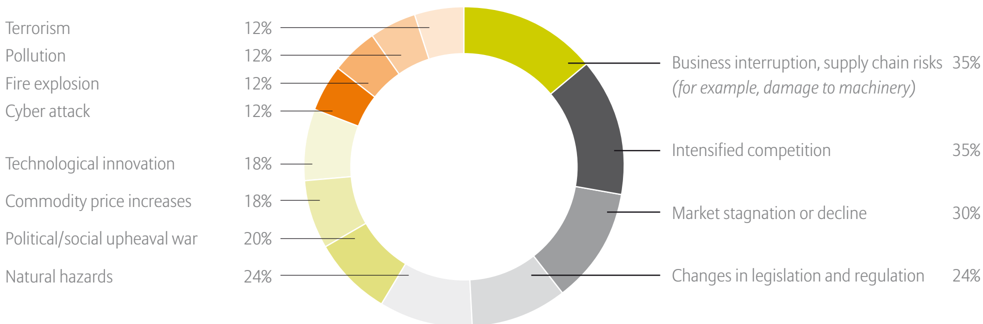
According to AGCS there is increasing concern in the aviation sector about the impact a large-scale cyber attack could have, particularly given the interconnected world of booking systems and client data. Data breaches and cyber terrorism are perceived to be growing threats

Every day the aviation sector faces a multitude of risks that can potentially jeopardize the success of their operations if they are not managed adequately.

Business interruption (both physical- and non-physical damage) and supply chain risks are currently the greatest concern for aviation practitioners, according to the Allianz Risk Barometer 2014, an annual global risk study conducted among risk consultants, senior managers and claims experts with both AGCS and local Allianz entities (*see chart*). Intensified competition and market stagnation/decline, natural hazard risk, regulatory change and technological innovation also rank highly on this risk register.

But in addition to these perils and other risk challenges discussed elsewhere in this study such as human factors, increasing automation in the cockpit and increasing use of composite materials, a number of other new potential threats will be increasingly in the risk spotlight in future.

Key risks for the aviation industry:



Source: Allianz Risk Barometer 2014

Note: Respondents could select more than one risk

Pilot shortage and training issues

Growing demand for air travel is presenting the aviation industry with the challenge of having to find hundreds of thousands of new pilots in the future.

One of the world's biggest training companies CTC Aviation has estimated that 235,000 pilots will need to be found in the next seven years with the commercial jet fleet forecast to almost double to 40,000 by 2030*.

Meanwhile, a Boeing report estimated that 498,000 new commercial airline pilots will be required over the next two decades**.

With the cost of training almost running to six figures in many cases this has raised concerns about whether such quotas can be fulfilled with the British Airline Pilots' Association urging the government to support training and for airlines to share training costs.

When it comes to the subject of the training itself, as is discussed on page 38 of this study, following a number of high-profile incidents such as the 2009 Air France crash and last year's Asiana Airlines incident questions are increasingly being asked about whether airline pilots are now too reliant on automation.

Pilot lapses and automation were implicated in these incidents with concerns being raised that because pilots have become so dependent on automation poor manual flying skills and a failure to master the latest changes in cockpit technology pose an increasing threat to passengers.

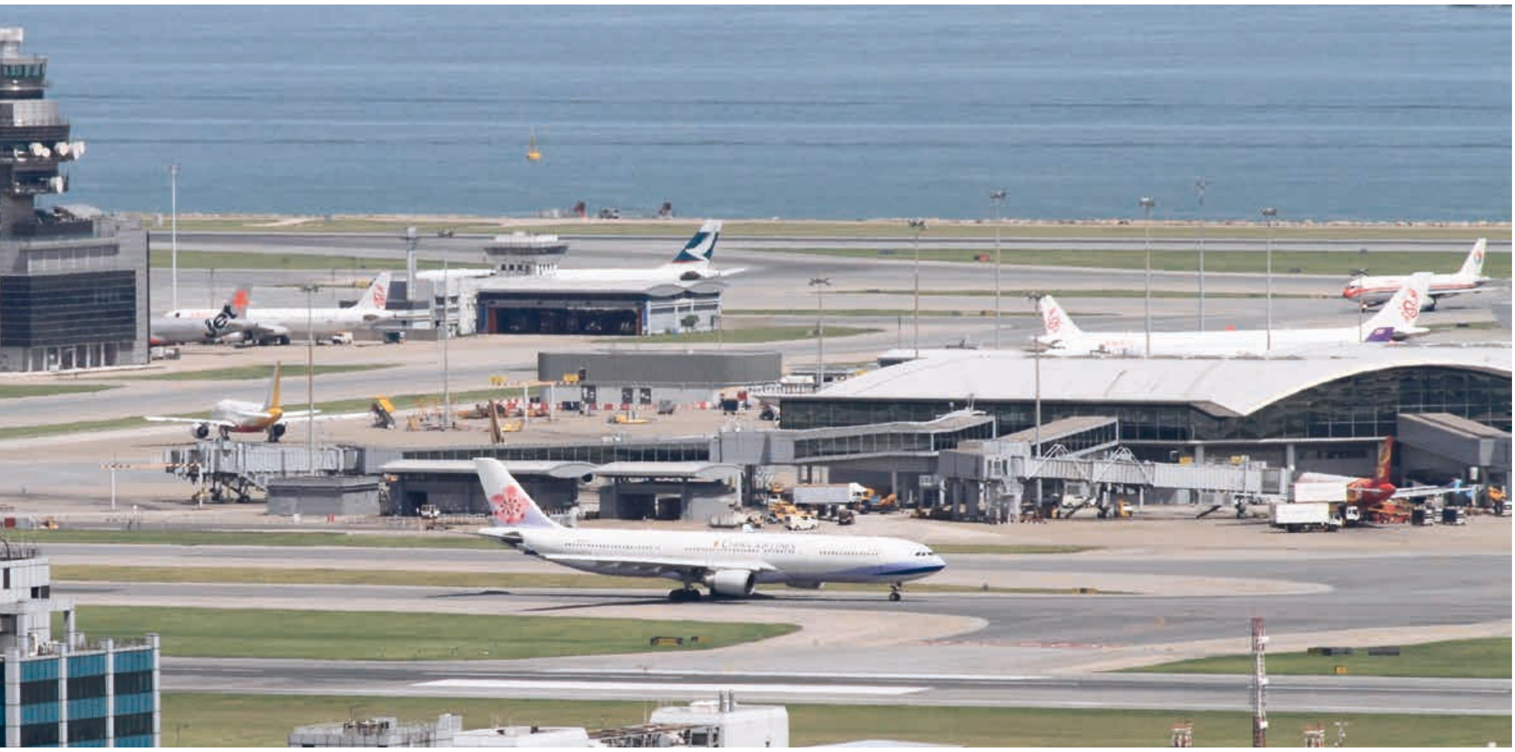
Training has changed and improved, but more focus should be placed on continuous training with pilots flying with and without automation. There has to be better preparation of pilots to fly and recover the aircraft if the automation fails. Improvements have to be made, especially to get rid of passivity in the cockpit due to automation. Pilot training should be changed to address this issue.

* CTC Aviation

**Boeing forecasts increased global demand for airline pilots

"When we underwrite a risk, we look at the equipment, pilot qualifications, the mission and the geography. It's the combination of those and other things that gives us a risk profile. An operator flying in and out of Phoenix every day with the latest equipment has a risk profile different from that of someone flying to an unimproved runway in an area with terrain and weather issues. We spend a lot of time looking at where you fly, what you fly and how you fly."

Joe Strickland
Global Head of Aviation, Americas, AGCS



The prospect of increasing turbulence and a potential shortage of pilots are some of the future challenges faced by the aviation industry.
Photo: Wikimedia Commons

Fasten your seat belts – more turbulence on the way

Scientists have forecast that turbulence will increase in the North Atlantic flight corridor in future due to the changing climate. A report published in the journal Nature Climate Change* predicts that one effect of a warming planet is that international flights will get more turbulent by the middle of this century.

Turbulence during transatlantic flights will occur with greater frequency and intensity if carbon dioxide emissions double by 2050 as the International Energy Agency forecasts, the report warns.

Turbulence can happen without warning and is caused by climate conditions such as atmospheric pressure, jet streams, cold and warm fronts or thunderstorms. The chances of encountering significant turbulence would increase by between 40% and 170% on the North Atlantic flight corridor, where 600 jets travel between Europe and North America each day, by the middle of the century.

Light turbulence shakes the aircraft, but more severe episodes can injure passengers and cause structural damage to planes, costing an estimated $150m a year.

*University of Reading research

Battery issues

Meanwhile, some of the teething problems Boeing's revolutionary 787 Dreamliner has experienced related to its lithium-ion batteries have been well-documented. In its first year of service at least three aircraft suffered from electrical system problems stemming from batteries including one that led to a fire aboard a 787 in Boston in January 2013.

Regulators subsequently grounded the 787 fleet for three months while a steel containment box and other measures were designed to stifle battery fires on the jet.

In March this year, Reuters* reported that a joint review by the plane maker and the FAA concluded that the Dreamliner was soundly designed and safe to fly. The review, which was initiated by the FAA after the Boston fire encompassed the entire plane.

The recommendations called for the FAA to improve its oversight of Boeing's part suppliers including those outside of the US and urged the company to ensure suppliers were fully aware of their responsibilities.

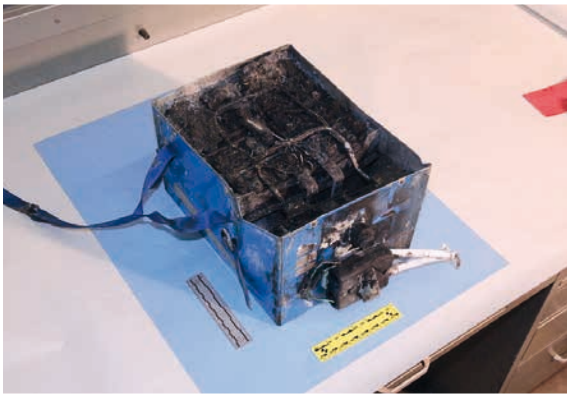
However, in May the NTSB called for lithium-ion batteries on the Dreamliner to undergo more testing. It urged the FAA to develop better tests for the uncontrolled heating which led to the Boston fire, require the tests for future aircraft designs, as well as checking whether 787s and other planes that have the batteries need more testing**.

Meanwhile, in August 2014 Reuters*** reported that cold winter temperatures were a factor in the meltdown of a lithium ion battery in one of the other Dreamliner incidents, when the plane was forced to make an emergency landing in Japan last year. Low temperatures can cause a lithium ion battery to deteriorate, resulting in the risk of a short circuit, Kyodo News reported separately. The battery is located in an unpressurized, unheated part of the plane.

However, it is not just such incidents which have raised concerns about the threat lithium batteries pose to aviation safety.

Whether it is cameras, laptops or electronic books, today's aircrafts are increasingly filled with passengers carrying hundreds of electrical devices.

UK aviation regulator, the Civil Aviation Authority has been among those stakeholders who have already warned about the potential impact of such batteries aboard aircrafts – and cheap imitations in particular. Just one small battery is powerful enough to explode and start a fire.



A heavily burned battery from an airplane after suffering thermal runaway. An increase in temperature changes conditions in a way that causes a further increase in temperature.

*US FAA review says Boeing 787 Dreamliner is safe - Reuters

** NBC News

***Low temperature a factor in Boeing 787 battery meltdown - Reuters

Growth of UAVs poses increasing challenges

Unmanned Aerial Vehicles (UAVs) – more commonly known as drones – are powered aerial vehicles which do not carry a human pilot on board. Instead they are controlled either autonomously by computers in the vehicle or under the remote control of a pilot. Originally, designed for military purposes, the UAV industry is developing at a rapid pace with the manufacturing industry having grown by double-digits annually since 2007[64].

The technology has already found a wide range of potential uses, including border and coastal patrols, filming news and sporting events, crop dusting and surveys.

Compared with manned aviation, the worldwide regulation of UAVs is in its infancy, as evidenced by the numerous organizations pursuing harmonization. Some countries impose relatively strict regulations for UAVs, other have less rigorous requirements. Others are yet to even consider the issue.

The potential risks are obvious, namely collision or third party damage or injury and resulting liability. AGCS sees a potential risk in the loss of control due to frequency interferences as there have been such incidents in the past with radio control models including fatalities.

A concern for insurers is the lack of data with regard to operation and loss in the UAV universe. Annual utilization, number of accidents and repair costs are not readily available and unmanned aircraft are not presently flying at the rate that they will be in the near future in the national airspace. Yet these are key underwriting points for most aviation risks.

However, an original set of data* presented with analysis based on studies of unmanned US military aircraft accidents (i.e not in active operational environments) reveals some interesting findings. The white paper investigates unmanned mishaps over a 10-year-period through fiscal year 2013 and notes that the increased participation of unmanned aircraft in US Air Force operations has resulted in a dramatic increase in the percentage of overall "Class A mishaps". A "Class A mishap" is defined as a non-combat accident that results in a death, a permanent total disability or damage of at least $1m. During the period of the study there were a total of 75 "Class A" Air Force mishaps in relation to unmanned aircraft. At the start of the study set in 2004 UAVs accounted for around 21% of all "Class A" Air Force mishaps. By 2011 this had grown to 50%, although the past two years have shown an improvement.

Pilot/human error accounted for 27.5% of the recorded mishaps with 58% due to failure issues with the hardware of the aircraft. Engine fire and weather were not significant factors in the cause of incidents.

The causes of the accident are likely to be of critical importance as a starting point for determining future risk and liability trends, particularly given the FAA's planned integration of UAVs into US airspace in 2015 is the most important factor that will influence how this technology is ultimately used by the civilian population and the eventual size of the industry.

* Risk Product Liability Trends, Triggers and Insurance In Commercial Aerial Robots - David Beyer, Donna Dulo, Gale Townsley and Stephen Wu

"UAVs in commercial use will **increase greatly** in the next **10 years**, because they are **very effective** at carrying out tasks under certain conditions, especially in **unsafe and dangerous environments**."

Josef Schweighart
Head of Aviation Germany, AGCS

Moo-ove out of the way - Cows on the runway and a $1bn bird strike bill

In January 2009 US Airways Flight 1549, an A320-214, en route from New York's LaGuardia Airport to Charlotte, North Carolina, ditched into the Hudson River seven minutes after takeoff. All 150 passengers and five crew survived, with only five serious injuries. The accident was due to a collision with a flock of Canada geese, which severely damaged both engines.

Although this was a high-profile incident due to the surrounding circumstances, bird strikes are a significant threat to flight safety, and have caused a number of accidents with human casualties. According to AGCS analysis of business insurance claims* they are already a notable cause of loss averaging $22.8m (€16.7m) every year between 2009 and 2013 with a total of 34 incidents (27 to airlines) in the analyzed claims.

Most accidents occur when the bird hits the windscreen or flies into the engines. These cause annual damages that have been estimated at $400m** within the US alone and up to $1.2bn to commercial aircraft worldwide.

Attempts are being made to reduce further the number of strikes on takeoff and landing at airports through bird management and control. Strategies include changes to habitat around the airport to reduce its attractiveness to birds. Vegetation which produces seeds and grasses which are favored by geese, and human-made food, a favorite of gulls, needs to be removed from the airport area. Trees and tall structures which serve as roosts at night for flocking birds or perches should also be removed or modified to discourage bird use.

Animals wandering onto runways can be an issue in some African countries.
Photo: Shutterstock

Other approaches include utilizing sounds, lights, pyrotechnics, radio-controlled airplanes, decoy animals, lasers and dogs. Firearms are also occasionally employed. A successful approach has been the use of dogs, particularly border collies, to scare away birds and wildlife. Another alternative is bird capture and relocation. Trained falcons are sometimes used to harass the bird population, as for example at John F. Kennedy International Airport.

However, birds are not the only animals that can cause aviation losses. The wandering onto runways by zebras in Africa and cows in a number of Latin American and Asian countries has resulted in a number of incidents resulting in insurance claims in recent years, largely driven by the aircraft hitting the animals in question.

Examples include:

Colombia: Incident in January last year which occurred in Necocli, Antioquia when a small, light passenger aircraft sustained significant structural damage following an incident with a cow on the runway. The plane was regarded as a constructive total loss.

Honduras: In September 2011 in Utila a light passenger aircraft was taking off when it came into contact with a cow, resulting in serious damage to the landing gear.

Indonesia: A passenger airliner hit a cow as it came into land on the island of Sulawesi. No one was reported injured but the plane sustained damage.

Venezuela: In March 2012 a passenger aircraft hit two cows while landing, killing both animals and causing significant damage to the aircraft. The cows were on the runway as the plane came into land in the Santo Domingo region, resulting in the cow colliding with the plane's left main landing gear and wing flaps.

And finally... One of the more unusual causes of loss was recorded in Kenya where an aircraft struck a herd of zebras while landing, caused major damage to the aircraft but fortunately no human injuries.

* Global Claims Review 2014, Allianz Global Corporate & Specialty
** www.independent.ie

"In risk assessment the key is to understand the entire chain of the procedures, process and equipment of an airline from the ground-up."

Henning Haagen,

Global Head of Aviation, EMEA and Asia Pacific, AGCS

Photo: Shutterstock

Cyber "weapon of choice" against aviation community

Hijacking an aircraft has become increasingly rare since the security measures put into place after September 11th, 2001. Worldwide, the last successful confirmed hijacking incident was in February 2014 and involved Ethiopian Airlines FL 702. The hijacker was the co-pilot who locked the captain out of the cockpit when the captain went to use the restroom. The aircraft was to land in Rome but the co-pilot flew to Geneva to request political asylum*. Security protocols and safety procedures in place at most of the world's airports are the primary means of deterring and preventing a potential hijacker.

The use of Advanced Imaging Technology (AIT) units represents the best available technology to safely screen passengers for metallic and non-metallic threats including weapons, explosives and other objects concealed under layers of clothing without physical contact.

In addition, radiation scanners, chemical sensors, and closed-circuit television cameras audit the movements of shipping containers, and passengers. At the airport positive baggage matching ensures that people cannot put luggage on planes, and then not board. Onboard the aircraft safety precautions include locking and reinforcing the cockpit doors, so terrorists cannot break in. However, by limiting the potential hijackers from gaining control of an aircraft, these safety precautions have given rise to a new threat, – cyber terrorism.

The aviation industry is facing major cyber risks on all fronts – on the ground and in the air – given the sector relies on computer systems for almost every aspect of its business.

According to the Allianz Risk Barometer 2014, the threat of a cyber risk was ranked as the eighth highest risk facing the sector – the first time it had appeared in the top 10 – and is expected to move up this list when the 2015 rankings are published. Data breaches and cyber terrorism are perceived to be growing threats.

Cyber terrorism can take several forms, but ultimately is a means of deliberately attacking or threatening targets by means of utilizing the internet as a common conduit by which computers and smart phones are intimately connected[65]. Cyber terrorism may replace the hijacker and bomber and become the weapon of choice on attacks against the aviation community.

New generation aircraft are facing an increased threat due to the more prevalent use of data networks, data uplinks, and downlinks, computer systems onboard, aircraft control navigation systems, environmental systems, propulsion systems, and control surface systems.

The fact that airlines are increasingly offering wi-fi internet services onboard their aircrafts is also a concern to many computer security professionals. Globalization of the internet and aviation requires a global solution which is being addressed by ICAO. It has adopted an amendment to Annex 17 (Security) effective March 26, 2011. This requires member states to develop measures to protect communication technology systems for civil aviation from interference that may jeopardize the safety of civil aviation. Both the FAA and EASA are continuing their efforts to harden aviation systems against cyber terrorists.

Faced with the increasing likelihood of a cyber attack, the aviation sector, which has spent an estimated $100bn on security since the 9/11 attacks, will need to review the areas to which its security spend is currently allocated, particularly given resources are not infinite.

Previously, IATA has called for a partnership between industry stakeholders, governments and regulators to enhance aviation security via a globally-harmonized risk-based system. This will require appropriate training of security specialists. Concurrently, the demand for risk mitigation solutions such as cyber insurance protection, for example, is expected to increase.

* www.bbc.com/news/world-europe-26222674

Aviation insurance explained

Few industries move at the same pace as the aviation industry. This speed of change poses unique challenges for both the sector and its insurers.

The aviation industry faces a number of potential liabilities arising from the loss of an aircraft, passenger and third party bodily injury, property damage, manufacturers' product failures, airport operations exposures, as well as the legal challenges faced by all industries doing business in today's increasingly litigious society.

In general, these different risks can be covered by the following types of insurance:

Airlines insurance and major risks: "All risks" hull (physical damage) and liability protection for passenger and cargo airlines, covering the full range of operations from single aircraft to major international carriers. Specialist solutions are also available to cover "war" risk, arising from hostile acts.

Aerospace insurance: Physical damage and liability cover for manufacturers and suppliers as well as for airports, airfields, refuelers and associated service providers.

General aviation insurance: Hull and liability cover for smaller aircraft and helicopters including privately-owned aircraft, commercial activities and fleets, clubs and flying schools, business jets and ground service providers.

Traditional property and casualty insurance markets may exclude insuring typical aviation exposures due to the complexity of the risks involved. Therefore the aviation insurance marketplace consists of underwriting companies that specialize in aviation and aerospace coverage with the business being brought to this community via retail and wholesale brokers.

As this study demonstrates major aviation incidents such as the loss of a plane do not occur frequently but the severity of such losses can be an issue. Due to the high risks and large sums of money involved airplanes are therefore usually insured on a subscription or co-insurance basis. This means that the risk is spread between a number of different insurers with each taking "a line" or percentage (with one or even more than one carrier taking a lead share) of the total risk, thereby limiting the exposure for the individual companies.

Insurers such as AGCS also have their own risk consulting teams, often including master engineers, pilots, lawyers and industry experts which assist industry practitioners in the management, mitigation and control of risks that may jeopardise the success of their aviation operations.

For more information visit
www.agcs.allianz.com/services/aviation/

www.agcs.allianz.com/risk-consulting/

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Embry-Riddle Aeronautical University
Campuses: Daytona Beach, Florida; Prescott, Arizona; and the Worldwide Campus.

Tel: +1 386-226-6100 or +1 800-862-2416
Email: DaytonaBeach@erau.edu

www.erau.edu

Editor: Greg Dobie (greg.dobie@allianz.com)

Contributors: Annika Schuenemann and Aram Gesar

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Allianz Global Corporate & Specialty SE Fritz-Schaeffer-Strasse 9, 81737 Munich, Germany
Commercial Register: Munich, HRB 208312

www.agcs.allianz.com

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Contact us

For more information, please contact your local Allianz Global Corporate & Specialty Communications team.

London
Jonathan Tilburn
jonathan.tilburn@allianz.com
+44 203 451 3128

New York
Jacqueline Maher
jacqueline.maher@agcs.allianz.com
+1 646 472 1479

Rio de Janeiro
Juliana Dias
juliana.dias@allianz.com
+55 21 3850 5958

Munich
Heidi Polke
heidi.polke@allianz.com
+49 89 3800 14303

Paris
Florence Claret
florence.claret@allianz.com
+33 1 5885 8863

Singapore
Wendy Koh
wendy.koh@allianz.com
+65 6395 3796

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