IATA

50 Years

SAFETY REPORT 2013

- AT THE FOREFRONT OF AVIATION SAFETY -


JEPPESEN
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SAFETY REPORT 2013

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Montreal—Geneva

50th Edition

NOTICE

Senior Vice-President
Safety and Flight Operations
International Air Transport Association
800 Place Victoria
P.O. Box 113
Montreal, Quebec
CANADA H4Z 1M1

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"Working together, we have made aviation the safest form of long-distance travel ever invented."

Senior Vice-President Foreword

Captain Kevin Hiatt
Senior Vice President
Safety and Flight Operations

This year marks two incredible milestones for aviation: 100 years ago the first commercial flight occurred between the cities of St. Petersburg and Tampa in the United States; and 50 years ago IATA published our first Safety Report. Much has changed in that time. Flying has become ever more accessible, attracting billions of passengers each year, all of whom rely on the industry to get them where they are going safely and in one piece.

That they may do so with confidence is owing to the tireless efforts of industry stakeholders, both public and private. Working together, we have made aviation the safest form of long-distance travel ever invented. As safety has improved and accidents have become exceedingly rare, we have redoubled our efforts, seeking to identify potential risks and develop prevention strategies before they can become threats. Such predictive methods rely on the collection and analysis of enormous amounts of information, which industry stakeholders provide voluntarily in the interests of further improving safety. We have also developed standardized audits that can highlight possible areas within an airline that may require additional attention.

We can be proud of our efforts; they have resulted in aviation being a model for safety. Programs developed by the aviation industry, such as Safety Management Systems, are being adopted by other industries such as healthcare and nuclear energy. But we cannot rest on our laurels. We must continue to develop these efforts and find ways to innovate. Every accident is one too many and we are committed to improving the already high standards of safety.

I am pleased to offer you this 50th edition of the IATA Safety Report and encourage you to share the vital information contained in these pages with your colleagues. I would like to thank the IATA Operations Committee (OPC), the Safety Group (SG), the Accident Classification Task Force (ACTF), the Cabin Operations Safety Task Force (COSTF) and all IATA staff involved for their cooperation and expertise essential for the creation of this report.

"I would particularly like to thank the members of the IATA Accident Classification Task Force for their dedication; without which this report would not be possible."

Chairman Foreword

Dr. Dieter Reisinger
Chairman ACTF

It was at the dawn of the jet age that the first edition of this report was created. Fifty years later, a group of dedicated men and women from IATA, aircraft manufacturers, and airlines continue to review and analyze accident data, identify trends and provide recommendations to continuously improve commercial aviation safety. Over all these years, IATA and its leadership have provided a home for this group and can look back with pride on the fifty years of publication of this report. However, this is an achievement we all can be proud of. How many aviation-related publications do you recall that span half a century? IATA can rightly celebrate this special edition – it has led commercial aviation safety from the very early days of the jet age.

If you go through the archives and look at some older editions of the report, the gradual and (occasionally) revolutionary changes become obvious. You will notice that graphics and layout have changed over the years, mainly to enhance the interpretation of complex data. These changes were not without challenges; it is hard to believe that the introduction of color print was controversially discussed in our group in the early 2000 when color print was perceived to be distracting (the term "comic" was even used as an argument against the change). Driven by the LOSA program, the Swiss Cheese Model and the TEM Framework, the industry gave a high priority to accident causes buried within the organization. The taxonomy was adapted to better address latent conditions in the aviation system and, with the introduction of IOSA in 2003, airlines were given a tool to evaluate and quantify performance in an area that is otherwise difficult to grasp.

As the chairman I would particularly like to thank the members of the IATA Accident Classification Task Force for their dedication; without which this report would not be possible. This group is composed of fine men and women, all volunteers sponsored by their respective employers, with expert knowledge in different fields of aviation and a wide regional variance. It is wonderful to work with this group who, over the years, have become a family. IATA, with their dedicated team of safety specialists, data experts and graphic artists, turns data and analysis into consolidated recommendations and produces the final product. With the report now being published online and free-of-charge, IATA has clearly moved boldly forward. It is another step in our common goal "To lead the global airline commitment for continuous improvement in safety". May the report be useful to our readers for the next fifty years to come!

Safety Report 2013 Executive Summary

The IATA Safety Report is the flagship safety document produced by IATA since 1964. It provides the industry with critical information derived from the analysis of aviation accidents to understand safety risks in the industry and propose mitigation strategies. In keeping with the Safety Management System methodology, for the 50th edition of the report, IATA is introducing analysis from other data sources to provide a broader indication of risks and thereby a better indication of safety performance.

	Jet	Turboprop	Western-built Jet Hull Loss Rate	Fatal Accidents	Fatalities
2013	38	43	0.41	16	210
2012	29	46	0.21	15	414
Five year average	48	38	0.48	19	517

Accident Summary

This report is focused on the commercial air transport industry; it therefore uses more restrictive criteria than the ICAO Annex 13 accident definitions do. In total, 81 accidents met the IATA accident criteria in 2013. This report introduces a joint chapter with ICAO providing analysis of the 103 accidents that met the broader harmonized Global Safety Information Exchange criteria, including injury only accidents with no damage to aircraft, first introduced in 2011.

Summary data for 2013 provide the following observations:

- There were 210 fatalities from commercial aviation accidents in 2013, reduced from 414 in 2012 and less than the five-year average of 517.
- The 2013 global Western-built jet hull loss rate was 0.41. This was a step back from 2012 when the global Western-built jet hull loss rate stood at 0.21 - the lowest in aviation history. Looked at over the five-year period (2009-2013), 2013 shows a 15 percent improvement from the 5-year average of 0.48.
- The 2013 Western-built jet hull loss rate for members of IATA was 0.30, which outperformed the global average by 26.8% and which showed an improvement over the five year average of 0.32.

New IATA Safety Strategy

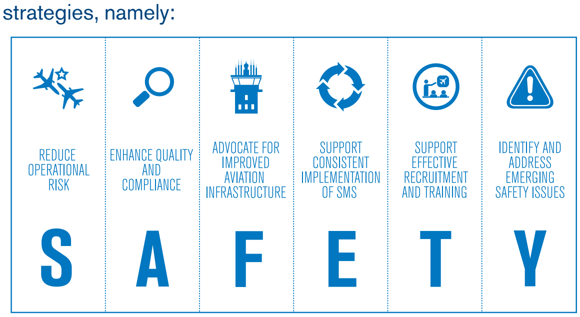
As part of our ongoing efforts to regularly review our strategic priorities to ensure they are still fresh and relevant to the aviation industry, the IATA Safety Group has developed a new Six-Point Safety Strategy. The former six-point safety program has made very significant improvements to operational safety within the industry. However, the new Six-Point Strategy reflects the current operational environment and provides the framework for proactive initiatives to mitigate the main causes of aviation accidents and incidents.

In September 2013, the IATA Safety Group initiated a comprehensive review of the IATA Six-Point Safety Strategy. Building on Safety Management System (SMS) principles, the Group reviewed input from several sources, including issues raised by airlines at the biannual Incident Review Meetings as well as analysis of safety factors by IATA's Global Aviation Data Management (GADM) team. GADM provides IATA members and other industry partners with a wealth of information and acts as a portal for multiple sources of aircraft operational data. This critical input formed the foundation of the new Safety Strategy and was endorsed by IATA's Operations Committee (OPC) in October 2013.

IATA's Safety Strategy is a holistic approach to identifying organizational and operational safety issues. Its key pillars are:

- Improved technology
- Regulatory harmonization
- Training
- Awareness

IATA will work closely with industry stakeholders to ensure each of these pillars is leveraged to address each of the six safety strategies, namely:



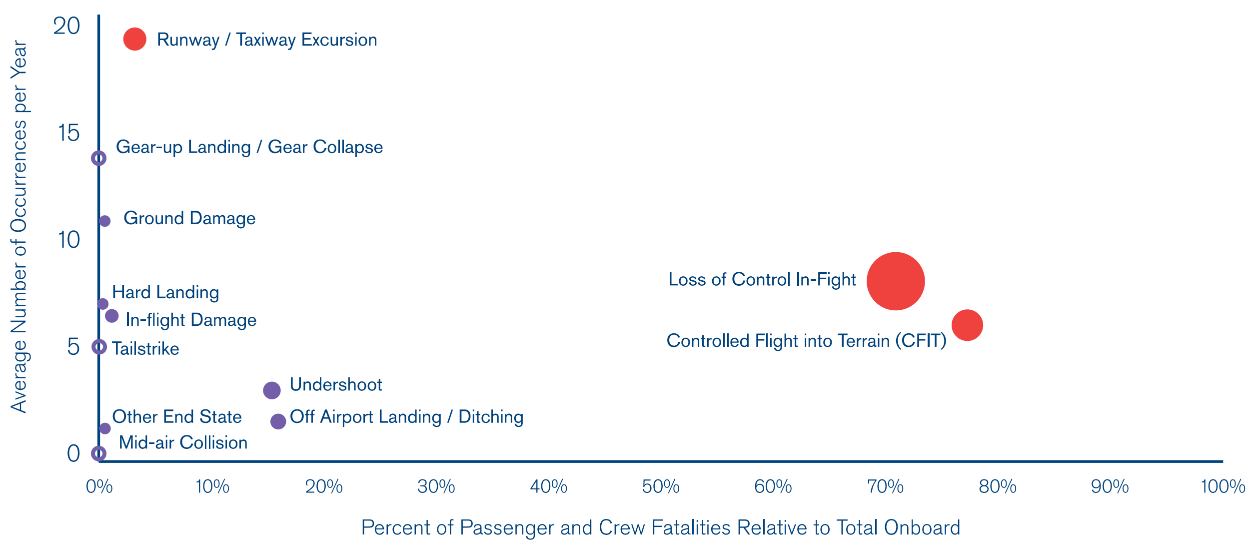
1. Reduce operational risk
2. Enhance quality and compliance
3. Advocate for improved aviation infrastructure
4. Support consistent implementation of SMS
5. Support effective recruitment and training
6. Identify and address emerging safety issues

High Risk Accident Categories

IATA has introduced the concept of high-risk accident categories into this year's report. This is designed to expand beyond the traditional methods of high frequency as a single metric for prioritization of mitigation efforts and incorporate a metric for accident outcome related to survivability.

In the chart below, each accident category is plotted by the average number of occurrences per year and the percentage of fatalities relative to the total number of people on board. The bubble size increases as the absolute number of fatalities for the category increases; empty bubbles indicate no fatalities for that accident category.

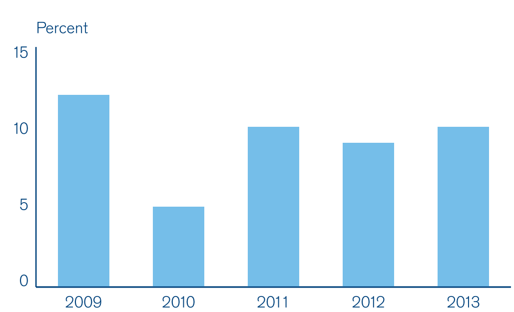
World 2009-2013



Note: Circle size increases as total fatalities increase; circles with white centers indicate no fatalities.

Loss of Control In-flight

While few in number, Loss of Control In-flight (LOC-I) accidents are almost always catastrophic; 95% of LOC-I accidents between 2009 and 2013 involved fatalities to passengers and/or crew. Over this period, 10% of all accidents were categorized as LOC-I. LOC-I accidents contributed to 60% of fatalities during the past five years (1,546 out of 2,585). There were eight LOC-I accidents in 2013, all of which involved fatalities. Given this severity, LOC-I accidents represent the highest risk to aviation safety.

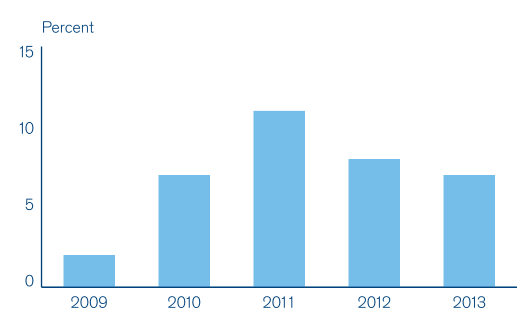


Loss of Control In-flight as a percent of total accidents

Controlled Flight into Terrain

Most Controlled Flight into Terrain (CFIT) accidents occur in the approach and landing phases of flight and are often associated with lack of precision approaches. There were six CFIT accidents in 2013.

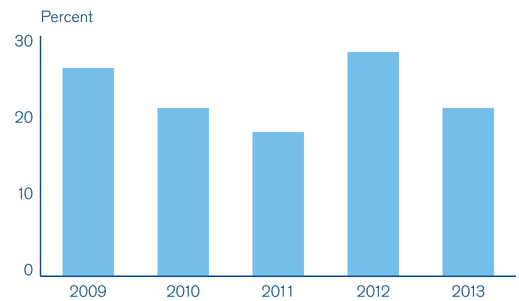
In the period from 2009 to 2013, data from the IATA Global Aviation Data Management (GADM) program shows that 52% of CFIT accidents involved the lack of precision approaches. There is a correlation between the lack of Instrument Landing Systems (ILSs) or state-of-the-art approach procedures - such as Performance-Based Navigation (PBN) - and CFIT accidents.



Controlled Flight into Terrain as a percent of total accidents

Runway Excursions

While there is a downward trend in aviation accidents overall, the trend for runway excursions has remained relatively unchanged. From 2009 to 2013, 58% of all accidents occurred in the runway environment. The most frequent type of accident is runway excursion, representing 23% of all accidents over the period. Survivability of such accidents is high Runway excursions represented less than 8% of fatalities over the previous five years. Improving runway safety is a key focus of the industry's strategy to reduce operational risk.



Runway Excursions as a percent of total accidents

IOSA

The IATA Operational Safety Audit (IOSA) is recognized as the global standard for airline operators. In 2009, IOSA certification was made a requirement for all 240+ IATA members. There are now over 388 airlines worldwide on the IOSA registry (www.iata.org). In 2013, IOSA registered operators had an accident rate 2.5 times better than non-IOSA carriers.

IOSA is being enhanced to include information from internal oversight assessments made by operators. Enhanced IOSA (E-IOSA) will widen the scope and augment the value of the audit result. In 2013 airlines began to undergo E-IOSA on a voluntary basis. In September 2015 E-IOSA will become mandatory for all renewal audits.

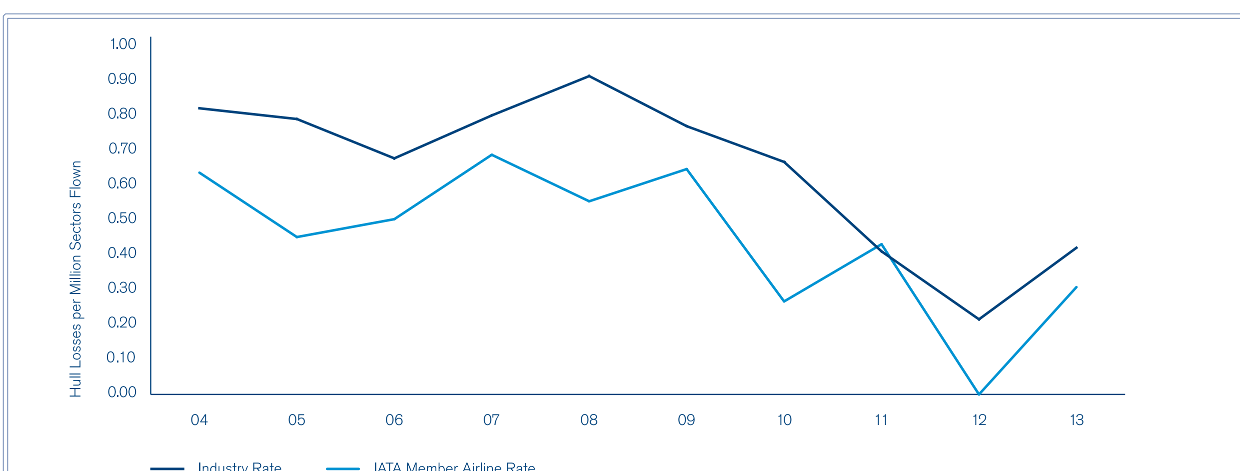
Safety Management Systems (SMS) provisions were added to IOSA in 2010, and all SMS provisions will become standards by 2016, making IOSA the first global SMS standard.

Regional Performance

- 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), 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)

In 2014, IATA will continue to work with its members to maintain safety as a priority. Building on the initiatives outlined in the IATA Safety Strategy, IATA will continue to represent, lead and serve the aviation industry in this critical area.

Western-built Jet Hull Loss Rate (2004-2013)

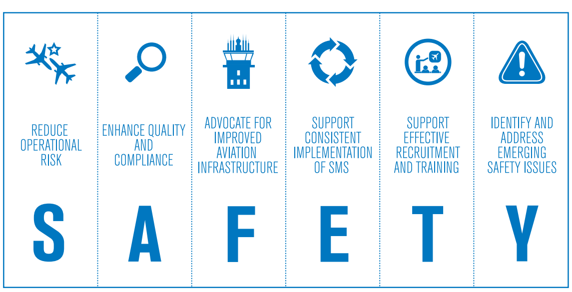


IATA Safety Strategy

50 YEARS AT THE FOREFRONT OF AVIATION SAFETY

To mark the 50th anniversary of the IATA Safety Report and as part of our ongoing efforts to regularly review our strategic priorities to ensure they are still fresh and relevant to the aviation industry, the IATA Safety Group has developed a new Six-Point Safety Strategy. The former six-point safety program has made very significant improvements to operational safety within the industry. However, the new Six-Point Strategy reflects the current operational environment and provides the framework for proactive initiatives to mitigate the main causes of aviation accidents and incidents.

In September 2013, the IATA Safety Group initiated a comprehensive review of the IATA Six-Point Safety Strategy. Building on Safety Management Systems (SMS) principles, the Group reviewed input from several sources, including issues raised by airlines at the biannual Incident Review Meetings as well as analysis of safety factors by IATA's Global Aviation Data Management (GADM) team. GADM provides IATA members and other industry partners with a wealth of information and acts as a portal for multiple sources of aircraft operational data. This critical input formed the foundation of the new Safety Strategy which was endorsed by IATA's Operations Committee (OPC) in October 2013.



IATA's Six-Point Safety Strategy

IATA's Safety Strategy is a holistic approach to identifying organizational and operational safety issues. Its key pillars are:

- Improved technology
- Regulatory harmonization
- Training
- Awareness

IATA will work closely with industry stakeholders to ensure each of these pillars is leveraged to address each of the six safety strategies, namely:

1. Reduce operational risk
2. Enhance quality and compliance
3. Advocate for improved aviation infrastructure
4. Support consistent implementation of SMS
5. Support effective recruitment and training
6. Identify and address emerging safety issues

Each of these six key areas breaks down into several subcategories to address specific aspects of the strategy.

REDUCE OPERATIONAL RISK

As a natural consequence of the service they provide, airlines are exposed to operational risks which must be continuously monitored and mitigated. IATA, through its Global Aviation Data Management (GADM) program, has identified three major areas of concern:

1. Loss of control in flight
2. Controlled flight into terrain
3. Runway safety

Other areas of operational risk identified include:

4. Flight management systems
5. Cabin safety
6. Fatigue risk

To address these areas, the IATA Safety Department has developed programs and strategies to reduce the operational risk to its member airlines and the aviation industry in general.

Loss of Control In-flight

Loss of Control In-flight (LOC-I) refers to accidents in which the pilot was unable to maintain control of the aircraft in flight, resulting in a deviation from the intended flight path. LOC-I can result from engine failure, icing, stalls or other circumstances that interfere with the ability of the pilot to control the motion of the aircraft. It is one of the most complex accident categories, involving numerous contributing factors that act individually or, more often, in combination.

While few in number, LOC-I accidents are almost always catastrophic; 95% of LOC-I accidents between 2009 and 2013 involved fatalities to passengers and/or crew. Over this period, 10% of all accidents were categorized as LOC-I. LOC-I accidents contributed to 60% of fatalities during the past five years (1,546 out of 2,585). There were eight LOC-I accidents in 2013, all of which involved fatalities. Given this severity, LOC-I accidents represent the highest risk to aviation safety. Therefore, IATA has embarked on a number of initiatives to increase the attention devoted to this important area of concern:

- IATA, in collaboration with aviation safety partners, is developing a Loss of Control Prevention (LOC-P) website and toolkit to provide a single-point-of-consultation where all relevant LOC and Aircraft Upset Recovery Training Aids (AURTA) will be available. The toolkit will also include Loss of Control Avoidance and Recovery Training (LOCART), the International Civil Aviation Organization (ICAO) Manual of Aeroplane Upset Prevention and Recovery (MAUPR), animations, workshop material, analysis reports, Flight Management System (FMS) data errors, and many other guidance and training materials. The toolkit will be completed in 2014.
- To address on-going LOC-I threats in airline operations, the IATA Training and Qualification Initiative (ITQI) recommends that Upset Prevention and Recovery Training (UPRT) in both aircraft and Flight Simulation Training Devices (FSTDs) be delivered by appropriately qualified instructors.

Controlled Flight into Terrain

Most Controlled Flight into Terrain (CFIT) accidents occur in the approach and landing phases of flight and are often associated with lack of precision approaches. There were six CFIT accidents in 2013.

In the period from 2009 to 2013, data from the IATA Global Aviation Data Management (GADM) program shows that 52% of CFIT accidents involved the lack of precision approaches. There is a correlation between the lack of Instrument Landing Systems (ILSs) or state-of-the-art approach procedures - such as Performance-Based Navigation (PBN) - and CFIT accidents. IATA works collaboratively with industry stakeholders such as ICAO, Air Navigation Service Providers (ANSPs) and airlines to leverage each of the pillars of our safety strategy as they relate to PBN implementation and to reduce the risk of CFIT:

- IATA is working to identify those regions where PBN Approaches with Vertical Guidance (APV) are most needed and expedite PBN implementation in accordance with ICAO General Assembly resolution A-37-11.
- IATA will launch a campaign to raise the profile of PBN implementation and explain the on-going risks of non-precision approaches. As an outcome of this campaign, IATA would like to see Non-Directional Radio Homing Beacon (NDB) and Very High Frequency Omnidirectional Range (VOR) approaches phased out and the implementation of PBN approaches with vertical guidance - primarily Barometric Vertical Navigation (VNAV) approaches - accelerated.

Runway Safety

While there is a downward trend in aviation accidents overall, the trend for runway safety has remained relatively unchanged. Events such as runway excursions, runway incursions, hard landings and tail strikes are still areas that must be improved.

From 2009 to 2013, 58% of all accidents occurred in the runway environment. The most frequent type of accident is runway excursion, representing 23% of all accidents over the period. Survivability of such accidents is high, representing less than 8% of fatalities over the previous five years. Improving runway safety is a key focus of the industry's strategy to reduce operational risk.

In this regard, IATA believes it is appropriate to address all runway safety issues in a comprehensive manner. It has embarked on the following series of programs:

- Through effective outreach and awareness initiatives, IATA shares information and lessons learned on runway safety issues, hazards and effective solutions with all industry stakeholders.
- IATA is taking the lead to establish a common taxonomy for runway safety in order to develop a universal set of key performance indicators (KPIs).
- A Runway Safety i-Kit is been developed in collaboration with IATA, ICAO, ACI, CANSO, ICCAIA, FSF, IFALPA, IFATCA, IBAC, IAOPA, FAA, EASA and EUROCONTROL.
- IATA supports regional runway safety seminars.
- The second edition of the IATA Runway Excursion Risk Reduction (RERR) Toolkit, which was developed jointly with ICAO to provide in-depth analysis of runway excursion accident data and comprehensive reference materials for the prevention and mitigation of runway excursion accidents, has been offered to industry. The RERR toolkit is available free of charge, including documents and videos.

Flight Management Systems

One of the key components of avionics in a modern airliner is the Flight Management System (FMS). A FMS reduces the flight crew's workload and enhances safety by automating a wide variety of in-flight tasks. However, following the "garbage in – garbage out" principle, a FMS is only as good as the data that is input by the pilot. Pilot data entry errors, especially in performance and navigational data, are potential contributing factors to accidents.

One of the problems in tackling FMS data entry errors is the number of FMS manufacturers, each with different software versions currently installed in fleets worldwide. Software updates and hardware modifications are a long-term but costly solution to reducing data entry errors. IATA is working to address this problem:

- IATA is compiling industry best practices and consulting with Original Equipment Manufacturers (OEMs) to develop workable solutions.
- IATA will publish a best practices guide for the prevention, trapping and mitigation of FMS data entry errors.

Cabin Safety

Cabin crew play an important role in preventing or mitigating accidents or serious incidents including, but not limited, to in-flight fires, unruly passengers, turbulence, and decompressions. IATA continues to focus on cabin safety, working with airlines, manufacturers and other industry partners to develop standards and best practices.

In 2013, IATA produced the first Cabin Operations Safety Best Practices Guide. The guidelines were drafted to assist the airline industry in implementing integrated, proactive, and effective policies and procedures for safe cabin operations. Because there is no "one-size-fits-all" solution, these guidelines stand as recommendations. Airlines are encouraged to adopt these guidelines as appropriate. IATA is committed to updating the guidelines annually in order to address emerging risks and share new best practices.

Fatigue Risk

The traditional regulatory approach to manage crew member fatigue has been to prescribe limits on maximum flight and duty hours, and require minimum breaks within and between duty periods. It is a "one-size-fits-all" approach that does not reflect operational differences. A Fatigue Risk Management System (FRMS) is an enhancement to flight and duty time limitations (FTLs), enabling an operator to customize FTLs to better manage fatigue risk in its operation. A FRMS allows an operator to adapt policies, procedures and practices to the specific conditions that result in fatigue risk in a particular aviation setting. There is scientific and operational support that FRMS is an effective means of mitigating fatigue risks. For this reason, IATA issued a white paper on FRMS in January 2013. The White Paper provides an overview of FRMS and its benefits. To further support member airlines with FRMS implementation, in 2014 IATA published the document "Fatigue Safety Performance Indicators (SPIs): A Key Component of Proactive Fatigue Hazard Identification". This document reviews different SPIs to help carriers develop processes and procedures to monitor the effectiveness of fatigue management approaches.

ENHANCE QUALITY AND COMPLIANCE

The importance of monitoring and oversight in the maintenance and improvement of aviation safety standards cannot be emphasized enough. Regulations must evolve as the industry grows and technologies change. The new IATA Safety Strategy focuses on the following key elements of quality oversight:

- Auditing (IOSA, ISAGO, IFQP)
- Oversight of Third Party Service Providers

Auditing - IOSA

IATA's Operational Safety Audit program (IOSA) is generally recognized as the "gold standard" for operators. Since the introduction of IOSA in 2003, the audit's principles and protocols have largely remained unchanged. The initial goals of establishing a broad foundation for improved operational safety and security and eliminating redundant industry audits have been reached. The program is now being enhanced to include information from internal oversight assessments made by operators. Enhanced IOSA (E-IOSA) will widen the scope and augment the value of the audit result. The key elements and changes to the audit model are as follows:

- Airline internal Quality Assurance (QA) programs will incorporate internal assessments of the airline's performance using the IOSA Standards and Recommended Practices (ISARPs) during the entire 24-month registration.
- A Conformance Report (CR) - a current record of the internal assessments compared to the ISARPs - will be provided to the Audit Organization (AO) before the renewal audit.
- The AO will review and verify the information from the CR as part of the overall IOSA assessment. The emphasis will be on confirmation of an effective QA program.
- Selected front-line operational activities will be observed to confirm implementation of IOSA standards.

In 2013 airlines began to undergo E-IOSA on a voluntary basis and in September 2015 E-IOSA will become mandatory for all renewal audits.

New Audit Program for Small Airlines

There are many small airlines that cannot meet the IOSA criteria because of the type(s) of aircraft they operate, the nature of their operations, or because they have elected not to pursue IOSA registration. Therefore, IATA will launch an assessment program for small airlines to target operational safety improvement. The assessment program will cover almost all non-IOSA commercial operators, with very few exceptions.

Auditing - ISAGO

The IATA Safety Audit for Ground Operations (ISAGO) improves ground safety and aims to reduce accidents and incidents. ISAGO is a standardized and structured audit program of Ground Service Providers (GSPs), that is, ground handling companies operating at airports. It uses internationally recognized operational standards that have been developed by global experts. The audits are conducted by highly trained and experienced auditors.

In addition to improving ground safety, ISAGO provides cost savings of up to 30% for both airlines and GSPs by decreasing the number of redundant audits.

Implementation of a five-year ISAGO strategy and audit concept plan was initiated in 2013. The focus of the plan is to simplify ISAGO and keep it relevant.

Over 700 ISAGO audits have been performed worldwide since 2008. In November 2013, the ISAGO registry had 144 registered providers with 246 registered stations at 168 airports worldwide. The ISAGO audit pool includes 41 member airlines with 260 ISAGO qualified auditors.

Auditing - IFQP

The IATA Fuel Quality Pool (IFQP) is a group of airlines that actively share fuel inspection responsibilities and reports. The IFQP enhances safety and improves quality control standards at airport fuel facilities worldwide. All inspections are performed by IFQP-qualified inspectors who use a standardized checklist that reflects current industry regulations. This ensures uniformity of standards, performance levels, quality, and safety procedures for everyone.

Oversight of Third Party Service Providers

Outsourcing of commercial functions to third party service providers is one of the largest corporate risks for carriers. As part of a carrier's SMS, oversight of third party activities is necessary to ensure hazards are not introduced that could affect the safety and security of aircraft operations. In order to achieve this, the carrier's hazard identification and risk management procedures must be integrated with those of the subcontractor, where applicable. IATA is working with both operators and service providers to develop material to facilitate conformity with this requirement.

ADVOCATE FOR IMPROVED AVIATION INFRASTRUCTURE

Working closely with IATA members, key partners such as ICAO, the Civil Air Navigation Services Organization (CANSO) and Airports Council International (ACI), state regulators and Air Navigation Service Providers (ANSPs), the IATA Air Traffic Management (ATM) Infrastructure department strives to ensure that ATM and Communication Navigation and Surveillance (CNS) infrastructure is globally harmonized, interoperable, and meets the requirements of the aviation industry. Advocating for improved aviation infrastructure is fundamental to addressing current and future operational deficiencies and safety risks.

By 2020, forecasts indicate that traffic is expected to increase by about:

- 50% in Asia
- 40% in South America
- 40% in the Middle East
- 11% in Africa

Supporting such traffic growth will require cost-effective investments in infrastructure that meet safety and operational requirements. The latest edition of the ICAO Global Air Navigation Plan (GANP) provides a framework for harmonized implementation of service level improvement enablers by aircraft operators and ANSPs.

The IATA Safety Strategy focuses on the following key priorities:

- Implementation of Performance-Based Navigation (PBN); particularly Approaches with Vertical Guidance (APV).
- Operational improvements and safety enhancements associated with the implementation of Aviation System Block Upgrade (ASBU) modules; e.g., Continuous Descent Operations (CDO) and Continuous Climb Operations (CCO).
- Collaborative Decision Making (CDM) to achieve safety and service level improvements.

Performance-Based Navigation with Vertical Guidance

From 2009 to 2013, 52% of Controlled Flight into Terrain (CFIT) accidents were shown to involve the lack of a precision approach. At their 37th General Assembly in September 2010, ICAO member states agreed to complete a national PBN implementation plan as a matter of urgency. The aim was to achieve PBN approach procedures with vertical guidance for all instrument runway ends by 2016.

Due to a low level of progress, IATA will launch an awareness campaign in 2014 to accelerate implementation of APV procedures and demonstrate the risks associated with the continued use of non-precision approaches. With this campaign, IATA aims to phase out NDB/VOR approaches and accelerate the implementation of APV. To achieve this goal, IATA will collaborate with ATM community partners (ICAO, CANSO, and ACI) to expedite the implementation of PBN and reduce the risks of CFIT.

Air Traffic Management

IATA implemented the following ATM infrastructure safety initiatives and activities in 2013:

- Promoted operational improvements and safety enhancements associated with the implementation of ASBU modules; e.g., PBN, CDO, CCO.
- Encouraged CDM to achieve infrastructure improvements.
- Advocated for global interoperability and harmonization, especially with the Single European Sky ATM Research (SESAR) program and the NextGen satellite navigation project in the United States.

SUPPORT CONSISTENT IMPLEMENTATION OF SMS

A Safety Management System (SMS) is a systematic approach to managing safety, including organizational structures, accountabilities, policies and procedures. In accordance with ICAO requirements, service providers are responsible for establishing a SMS that is accepted and overseen by their state regulator.

IATA is an active member of the ICAO Safety Management Panel and was involved in the drafting of the newest ICAO Annex, namely Annex 19 – Safety Management, which became applicable on 14 November 2013. Under these requirements, a SMS must:

- Identify safety hazards
- Implement remedial action necessary to maintain an acceptable level of safety
- Provide for continuous monitoring and regular assessment of safety levels
- Make continuous improvement to the overall level of safety

SMS is not a new concept. IATA introduced SMS-designated provisions in IOSA in 2010, which encompassed the ICAO SMS Framework as both Standards and Recommended Practices. Since then, over 330 audits have been completed, and the results are encouraging. There has been good progress in implementation, but the work is not complete. Recognizing the need to further the implementation of SMS, IATA developed the IOSA SMS Strategy, which provides a timeline for the progressive elevation of all SMS-designated SARPs to Standards by 2016.

IATA is committed to supporting all IOSA members in providing the necessary assistance to implement an effective SMS. Through continual monitoring of audit results, IATA will develop a strategy to support closure of IOSA findings related to elevated SARPs, including additional guidance and/or training on specific areas identified.

To further support SMS implementation in regions requiring more assistance, IATA developed and launched the Regional SMS Network. Its objectives are to facilitate the understanding of the ICAO SMS Framework, the IOSA SMS and requirements as well as explain how it applies to their operation in practical terms, resulting in effective implementation and improved conformity.

As additional help, the IATA Safety Strategy includes the following key actions to promote the consistent implementation of SMS:

- Safety performance monitoring
- Analysis and dissemination of information
- Safety promotion and facilitation
- SMS training courses for both airlines and regulators.

SUPPORT EFFECTIVE RECRUITMENT AND TRAINING

IATA's safety training portfolio includes courses dedicated to improving specific competencies as well as diploma programs focused on safety management, workplace safety, and best practices for civil aviation.

The IATA Safety Strategy focusses on competency-based training for the following key priorities:

- IATA Training & Qualification Initiative (ITQI)
- International Pilot Training Consortium (IPTC)
- Cabin crew competency-based training

IATA Training and Qualification Initiative

The IATA Training and Qualification Initiative (ITQI) seeks to modernize and harmonize the training of current and future generations of pilots and maintenance technicians. ITQI is a multi-faceted program supporting Multi-Crew Pilot License (MPL) training, Evidence-Based Training (EBT), Pilot Aptitude Testing (PAT), Instructor Qualification (IQ), Flight Simulation Training Device (FSTD) qualification criteria, and Engineering & Maintenance (E&M) training and qualification requirements.

ITQI works closely with ICAO and is complementary to its Next Generation of Aviation Professionals (NGAP) program.

Multi-Crew Pilot License (MPL) Training

Progress in the design and reliability of modern aircraft, a rapidly changing operational environment and the need to better address the human factors issue prompted an industry review of pilot training. The traditional hours-based qualification process fails to guarantee competency in all cases. Therefore, the industry saw a need to develop a new paradigm for competency-based training and assessment of airline pilots: Multi-Crew Pilot License (MPL) training.

MPL moves from task-based to competency-based training in a multi-crew setting from the initial stages of training. Multi-crew Crew Resource Management (CRM) and Threat and Error Management (TEM) skills are embedded throughout the training. The majority of incidents and accidents in civil aviation are still caused by human factors such as a lack of interpersonal skills (e.g., communication, leadership and teamwork), workload management, situational awareness, and structured decision making. MPL requires full-time embedded, as opposed to added-on, CRM and TEM training.

The global uptake of MPL is accelerating. In December 2013:

- 53 states had MPL regulations in place
- 16 states had Authorized Training Organizations (ATOs) running MPL courses
- A total of 2,330 students enrolled and 785 graduated.

The first edition of the IATA MPL Implementation Guide was published in 2011 to support airlines during their implementation process. In 2014, this guide will be updated based on data collected in 2013. This data was presented at the ICAO MPL Symposium, which took place in December 2013. The second edition will be published as a cobranded IATA/ICAO/IFALPA manual in 2014.

Evidence-Based Training

Evidence-Based Training (EBT) applies the principles of competency-based training for safe, effective and efficient airline operations while addressing relevant threats. ICAO has defined competency as the combination of Knowledge, Skills and Attitudes (KSAs) required to perform tasks to a prescribed standard under certain conditions.

The aim of an EBT program is to identify, develop and evaluate the key competencies required by pilots to operate safely, effectively and efficiently in a commercial air transport environment, by managing the most relevant threats and errors, based on evidence collected in operations and training. Several documents published in 2013 will allow airlines to develop an effective EBT program:

- ICAO Manual of Evidence-Based Training (Doc. 9995)
- Updates to ICAO Procedures for Air Navigation Services - Training (PANS-TRG, Doc 9868)
- IATA/ICAO/IFALPA Evidence-Based Training Implementation Guide

Implementation of EBT will enable airlines to develop more effective training programs and improve operational safety. In recognition of the importance of competent instructors in any training program, the EBT project provides specific additional guidance on the required competencies and qualifications for instructors delivering EBT.

Pilot Aptitude Testing

Designed to support aviation managers in the field of pilot selection, Pilot Aptitude Testing (PAT) is a structured, science-based candidate selection process. PAT helps avoid disappointed applicants, wasted training capacity, and early drop out due to medical reasons. Proven to be highly effective and efficient, PAT provides enhanced safety, lower overall training costs, higher training and operations performance success rates, a more positive working environment and reductions in labor turnover.

Instructor Qualification

ITQI's Instructor Qualification (IQ) addresses the need to upgrade instructor qualifications to conduct multi-crew pilot license (MPL) and other competency-based training. Traditional entry-level training for airline cadets often utilizes low-time flight instructors (FI) who are employed inexpensively while accumulating flying hours for airline operations. FI turnover is high and continuity is low. In addition, legacy training for a commercial pilot license (CPL) was based largely on a prescriptive hours-based approach. Today, the MPL training and other ITQI programs being rolled out for pilots and aircraft maintenance mechanics, technicians and engineers (AMMTE) are competency-based. While this method is a paradigm shift for many instructors, it is vital because the competence of a graduate is directly related to the quality of instruction.

Flight Simulation Training Device Qualification Criteria

IATA fully supports the new ICAO Flight Simulation Training Device (FSTD) qualification criteria and urges prompt action towards their adoption by the National Aviation Authorities (NAAs) of the world. The FSTD qualification criteria were developed for ICAO by the Royal Aeronautical Society (RAeS) International Working Group (IWG), in collaboration with IATA. The criteria reflect international agreement for a new standard of global classification of airplane FSTDs (Types I-VII).

Engineering and Maintenance Training and Qualification Requirements

ITQI's competency-based training for maintenance personnel is designed to establish a competent workforce in aircraft and maintenance organizations through a defined set of standards. The scope of the training is customized for each workplace and the pre-existing workforce competencies.

The aim of the Engineering and Maintenance (E&M) training and qualification program is to identify, develop and evaluate the competencies required by commercial aircraft maintenance personnel to operate safely, effectively and efficiently. This is accomplished by managing the most relevant risks, threats and errors, based on evidence.

E&M is geared toward individual student performance. The specification of the competency to be achieved, the evaluation of the student's entry level, the selection of the appropriate training method and training aids, and the assessment of a student's performance are key factors to the success of E&M.

International Pilot Training Consortium

IATA, ICAO, IFALPA and the RAeS have partnered to create the International Pilot Training Consortium (IPTC). Its aim is to develop ICAO provisions to improve the safety, quality and efficiency of commercial aviation by obtaining international agreement on a common set of pilot training, instruction and evaluation standards and processes.

Cabin Crew Competency-Based Training

Upgraded cabin safety requirements as well as improved cabin crew training are key factors contributing to recent positive developments in safer aircraft operations. IATA actively participated in drafting the ICAO Cabin Crew Safety Training Manual (Doc 10002) and will endorse this new guidance material that will be formally launched at the first IATA Cabin Operations Safety Conference in May 2014. The new guidance material is written with a competency-based approach to cabin crew safety training and includes important topics such as:

- Cabin crew safety training requirements and qualifications
- Training facilities
- Training devices
- Dangerous goods training
- Human performance
- Security
- Cabin health and first aid
- Safety Management Systems (SMS)
- Fatigue management
- Senior cabin crew training
- Cabin safety training management

IDENTIFY AND ADDRESS EMERGING SAFETY ISSUES

Techniques to improve aviation safety have moved beyond the analysis of isolated accidents to data-driven analyses of trends throughout the air transport value chain.

This approach is supported by IATA's Global Aviation Data Management (GADM) program. GADM is an ISO-certified (9001; 27001 certification in progress) master database that supports a proactive data-driven approach for advanced trend analysis and predictive risk mitigation. For more information on predictive analysis, please see Section 9. Pulling from a multitude of sources, GADM is the most comprehensive airline operational database available. These sources include the IATA accident database, the Safety Trend Evaluation Analysis and Data Exchange System (STEADES), IOSA and ISAGO audit findings, Flight Data Analysis (FDA) and Flight Data eXchange (FDX), the Ground Damage Database (GDDB) and operational reports, among others. More than 470 organizations around the globe submit their data to GADM and over 90% of IATA member carriers participate.

With GADM, the IATA Safety Department is able to provide the industry with comprehensive, cross-database predictive analysis to identify emerging trends and flag risks to be mitigated through safety programs. IATA's safety experts investigate these new areas of focus and develop preventative programs. One of the emerging issues the IATA Safety Department is currently working on is the transport of lithium batteries.

Transport of Lithium Batteries

Lithium (LI) batteries may have been a contributing factor in the loss of three cargo aircraft. Additionally, a number of fires in mail sorting rooms have been reported, following undocumented transportation of LI batteries by airmail on passenger aircraft.

Lithium batteries are classified as dangerous goods and are regulated for transport by air. IATA publishes the Dangerous Goods Regulations (DGR) which incorporate all of the provisions of the ICAO Technical Instructions (ICAO-TIs) together with additional operational requirements developed by the IATA Dangerous Goods Board (DGB). IATA is a standing member on the ICAO Dangerous Goods Panel (DGP). The DGP decided in 2012 to address the risks associated with LI battery transportation. These regulatory changes took effect in January 2013.

IATA has worked with various industry bodies to develop the Lithium Battery Best Practices Guide (LBBPG), designed to address the risks associated with the carriage of LI batteries. This guide is the first of its kind in the industry and has been designed to become a repository of information on the safe carriage of lithium batteries. A second edition of the LBBPG is to be published in 2014.

In 2013, IATA published the IATA Lithium Battery Guidance Document which complies with the 55th (2014) edition of the IATA DGR.

Training is a key component in understanding the regulations concerning LI batteries. In 2013, IATA introduced a training course on Shipping Lithium Batteries by Air that covers all aspects of the identification, packing, marking, labeling and documentation requirements on LI battery transport.

IATA, in conjunction with the DGB and the Dangerous Goods Training Task Force (DGTTF), has developed three new LI battery outreach and awareness products:

- Lithium battery passenger pamphlet
- Lithium battery shipping guidelines
- Lithium battery awareness poster

IATA is working closely with ICAO and other key industry stakeholders in reviewing the demand for further rulemaking required for the safe transport of lithium batteries.

The IATA Safety Department will continue to monitor trends through GADM to identify emerging risks and develop appropriate mitigating strategies.

For more information on IATA's Six-Point Safety Strategy, please go to: www.iata.org/6-point-safety

It may take hours for your aircraft to reach its destination
but its flight data will be in your hands within minutes
WIRELESS GROUNDLINK®
With Teledyne Controls' Wireless GroundLink® (WGL) solution, 100% data recovery is now possible. WGL eliminates physical media handling, putting an end to data loss.
Adopted by numerous operators worldwide, the Wireless GroundLink® system (WGL) is a proven solution for automating data transfer between the aircraft and your flight safety department. By providing unprecedented recovery rates and immediate access to flight data, WGL helps improve the integrity and efficiency of your Flight Data Monitoring (FDM) activities. With the right data at your fingertips, not only can you reduce operating risk and closely monitor safety, but you can also yield additional benefits across your organization, such as fuel savings and lower maintenance costs. Even more, the WGL system can also be used to automate wireless distribution of navigation databases and other Software Parts to the aircraft, when used with Teledyne's enhanced Airborne Data Loader (eADL). For as little as $24 dollars per month* in communication costs, all your data can be quickly and securely in your hands.
* May vary based on usage, cellular provider and country
Call +1 310-765-3600 or watch a short movie at:
www.teledynecontrols.com/wglmovie
Automatic Transmission
Cellular Technology
Secure-Encrypted Data
Back Office Integration
Low Operating Cost
The Wireless GroundLink system is available as a retrofit installation or factory fit from Airbus, Boeing and Embraer.
TELEDYNE CONTROLS
A Teledyne Technologies Company

Section 1

IATA Annual Safety Report

Founded in 1945, IATA represents, leads and serves the airline industry. IATA's membership includes some 240 airlines comprising approximately 84% of total air traffic. As at 1 January 2014, IATA had 53 offices in 52 countries.

IATA works closely with experts from its member airlines, manufacturers, professional associations and federations, international aviation organizations and other industry stakeholders to develop and improve aviation safety and to determine lessons learned from aircraft accidents.

INTRODUCTION TO THE IATA SAFETY REPORT 2013

The IATA Safety Report is the flagship safety document produced by IATA since 1964. It provides the industry with critical information derived from the analysis of aviation accidents to understand safety risks in the industry and propose mitigation strategies. In keeping with Safety Management Systems methodology, for the 50th edition of the report, IATA is introducing analysis from other data sources to provide a broader indication of risks and a better indication of safety performance.

The IATA Safety Report 2013 was produced at the beginning of 2014 and presents the trends and statistics based on the knowledge of industry at the time. This report is made available to the industry free of charge.

Image courtesy of Boeing

SAFETY REPORT METHODS AND ASSUMPTIONS

The Safety Report is produced each year and designed to present the best known information at the time of publication. Due to the nature of accident analysis, some assumptions must be made. It is important for the reader to understand these assumptions when working with the results of this report:

- Accidents analyzed and the categories and contributing factors assigned to those accidents are based on the best available information at the time of classification
- Sectors used to create the accident rates are the most up-to-date available at the time of production

The implementation of more advanced data processing will enable IATA to improve the sector information available for the current year and previous years. Therefore, it will be possible to provide even more accurate accident rates for previous years.

ACCIDENT CLASSIFICATION TASK FORCE

The IATA Operations Committee (OPC) and its Safety Group (SG) created the Accident Classification Task Force (ACTF) in order to analyze accidents, identity contributing factors, determine trends and areas of concern relating to operational safety and develop prevention strategies. The results of the work of the ACTF are incorporated in the annual IATA Safety Report.

It should be noted that many accident investigations are not complete at the time the ACTF meets to classify the year's events and additional facts may be uncovered in the course of an investigation that could affect the currently assigned classifications.

The ACTF is composed of safety experts from IATA, member airlines, original equipment manufacturers, professional associations and federations as well as other industry stakeholders. The group is instrumental in the analysis process, and produces a safety report based on the subjective classification of accidents. The data analyzed and presented in this report is extracted from a variety of sources, including Ascend FlightGlobal and the accident investigation boards of the states where the accidents occurred. Once assembled, the ACTF validates each accident report using their expertise to develop an accurate assessment of the events.

ACTF 2013 participants:

Mr. Marcel Comeau
AIR CANADA

Mr. Albert Urdiroz
AIRBUS

Capt. Denis Landry
AIR LINE PILOTS ASSOCIATION (ALPA)

Dr. Dieter Reisinger (Chairman)
AUSTRIAN AIRLINES

Capt. Robert Aaron Jr.
THE BOEING COMPANY

Mr. André Tousignant
BOMBARDIER AEROSPACE

Mr. David Fisher
BOMBARDIER AEROSPACE

Capt. Torsten Roeckrath (Vice-chairman)
CARGOLUX AIRLINES INTERNATIONAL

Capt. Jorge Robles
COPA Airlines Colombia

Mr. Luis Savio dos Santos
EMBRAER

Mr. Don Bateman
HONEYWELL

Mr. Gordon Margison
IATA (Secretary)

Mr. Michael Goodfellow
ICAO

Capt. Peter Beer
IFALPA

Capt. Hideaki Miyachi
JAPAN AIRLINES

Mr. Martin Plumleigh
JEPPESEN

Capt. Peter Krupa
LUFTHANSA GERMAN AIRLINES

Mr. Florian Boldt
LUFTHANSA GERMAN AIRLINES

Capt. Ayedh Almotairy
SAUDI ARABIAN AIRLINES

Mr. Steve Hough
SAS

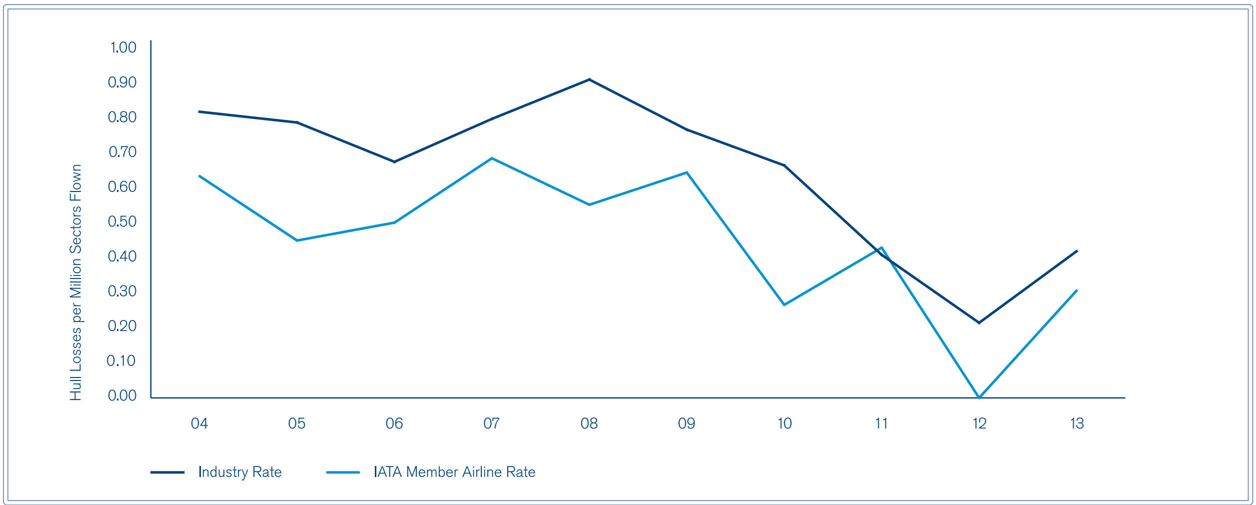
Capt. João Romão
TAP AIR PORTUGAL

Section 2

Decade in Review

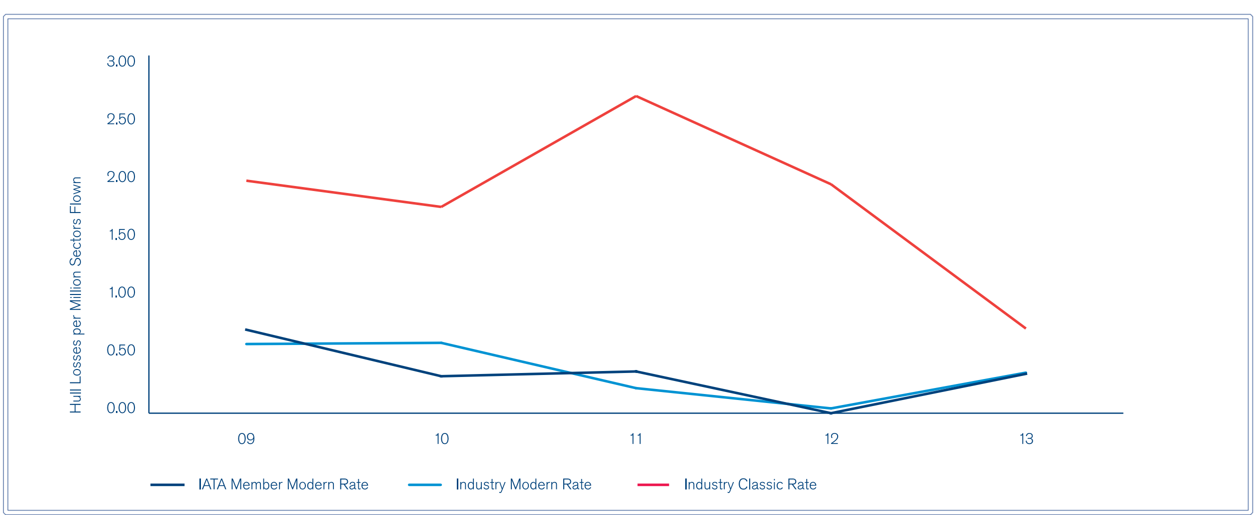
ACCIDENT/FATALITY STATISTICS AND RATES

Western-built Jet Aircraft Hull Loss Rate: IATA Member Airlines vs. Industry (2004-2013)



Modern Jet Hull Loss Rate (2009-2013)

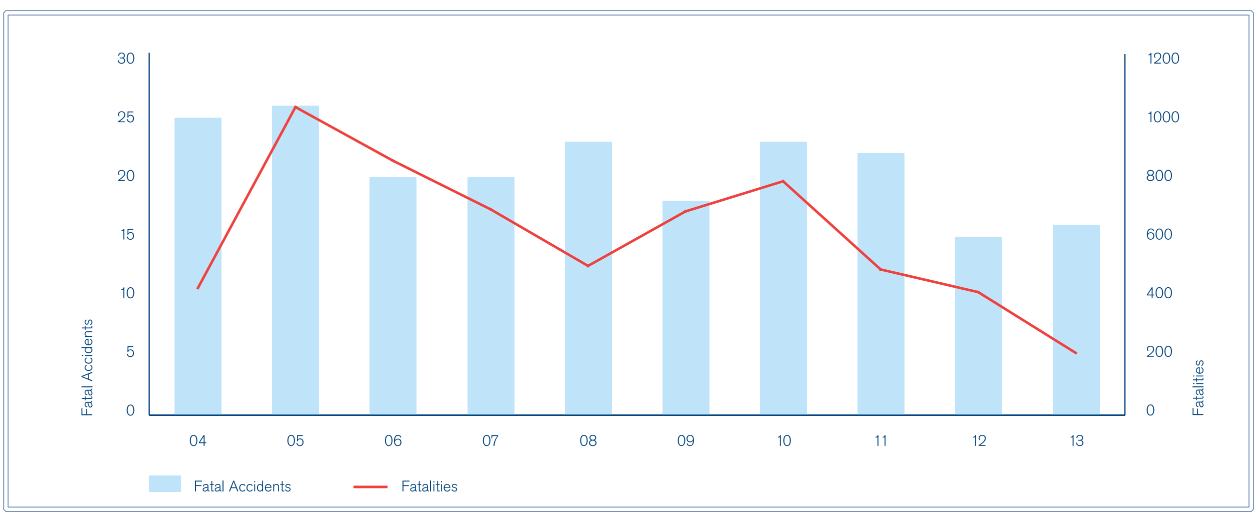
The Modern Jet Hull Loss rate includes aircraft initially certified after 1985 and equipped with a glass cockpit and Flight Management System (FMS) at initial certification. Aircraft using older technologies are considered “Classic”. This definition reflects the harmonizing of aircraft manufacturing and certification standards and the global manufacturing of aircraft components.



All Aircraft Accident Rate (2004-2013)

Note: Includes substantial damage and hull loss accidents for all Eastern-built and Western-built aircraft, including jets and turboprops.

Western-built Jet Aircraft: Fatal Accidents and Fatalities (2004-2013)



Source: IATA, Ascend - A Flightglobal Advisory Service

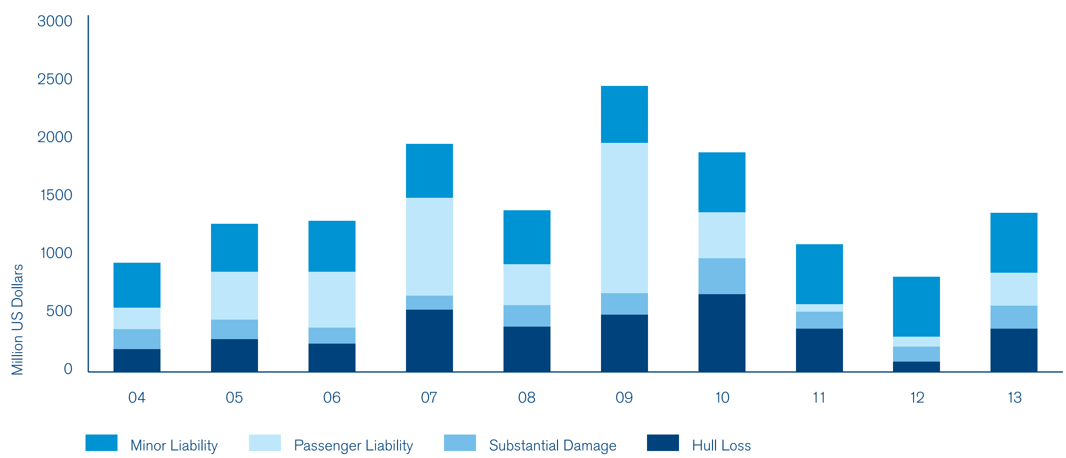
Western-built Jet Aircraft: Passengers Carried and Passenger Fatality Rate (2004-2013)

IOSA Registered and Non-IOSA Registered (2009-2013)

ACCIDENT COSTS

IATA has obtained the estimated costs for all losses involving Western-built aircraft over the last 10 years. The figures presented in this section are from operational accidents and exclude security-related events and acts of violence.

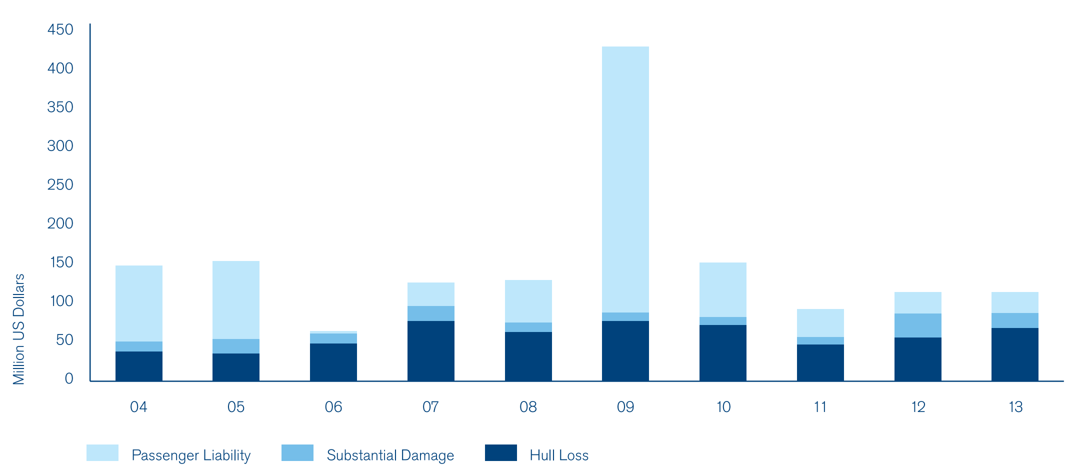
Western-built Jet Aircraft: Accident Costs (2004-2013)



Source: Ascend - A Flightglobal Advisory Service

Western-built Turboprop Aircraft: Accident Costs (2004-2013)

The sharp increase in turboprop passenger liability in 2009 is the result of an accident in a populated area with major damage on the ground.



Source: Ascend - A Flightglobal Advisory Service

Section 3

2013 in Review

AIRCRAFT ACCIDENTS

There were a total of 81 accidents in 2013. Summaries of all the year's accidents are presented in **Annex 3 - 2013 Accidents Summary**.

2013 Fleet Size, Hours and Sectors Flown

	Western-built Aircraft		Eastern-built Aircraft	
	Jet	Turboprop	Jet	Turboprop
World Fleet (end of year)	21,879	4,119	721	909
Hours Flown (millions)	59.66	5.69	0.40	0.29
Sectors -landings (millions)	29.31	6.70	0.16	0.19

Note: World fleet includes in-service and stored aircraft operated by commercial airlines on 31 December 2013.

2013 Operational Accidents

	Western-built Aircraft		Eastern-built Aircraft	
	Jet	Turboprop	Jet	Turboprop
Hull Loss	12	16	0	4
Substantial Damage	26	19	0	4
Total Accidents	**38**	**35**	**0**	**8**
Fatal Accidents	6	9	0	1

2013 Operational Hull Loss Rates

	Western-built Aircraft		Eastern-built Aircraft	
	Jet	Turboprop	Jet	Turboprop
Hull Losses (per million sectors)	0.41	2.39	0.00	21.05
Hull Losses (per million hours)	0.20	2.81	0.00	13.79

2013 Passengers Carried

	Western-built Aircraft		Eastern-built Aircraft	
	Jet	Turboprop	Jet	Turboprop
Passengers Carried (millions)	3,326	157	9	3
Estimated Change in Passengers Carried Since 2011	5%	1%	-12%	-7%

Source: Ascend - A Flightglobal Advisory Service

2013 Fatal Accidents per Operator Region

	AFI	ASPAC	CIS	EUR	LATAM	MENA	NAM	NASIA
Accidents	7	17	4	22	6	5	18	2
Fatal Accidents	5	2	3	0	1	0	5	0
Fatalities (crew and passengers)	56	52	76	0	8	0	18	0

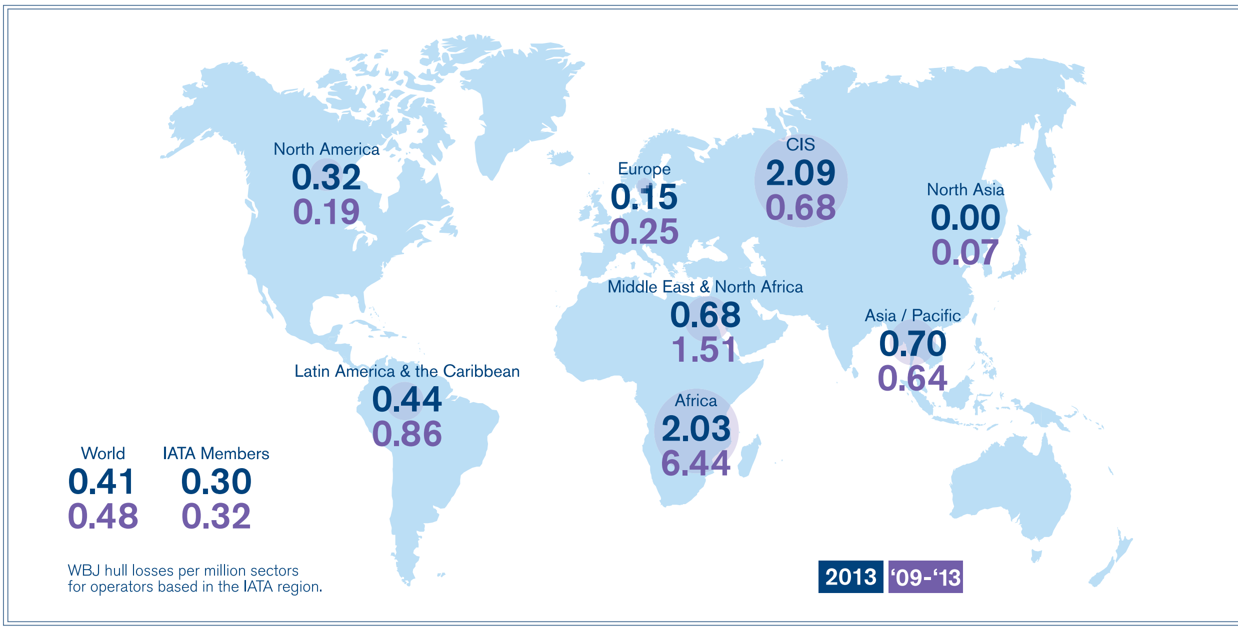
AIRCRAFT ACCIDENTS PER REGION

To calculate regional accident rates, IATA determines the accident region based on the operator's country. Moreover, the operator's country is specified in the operator's Air Operator Certificate (AOC).

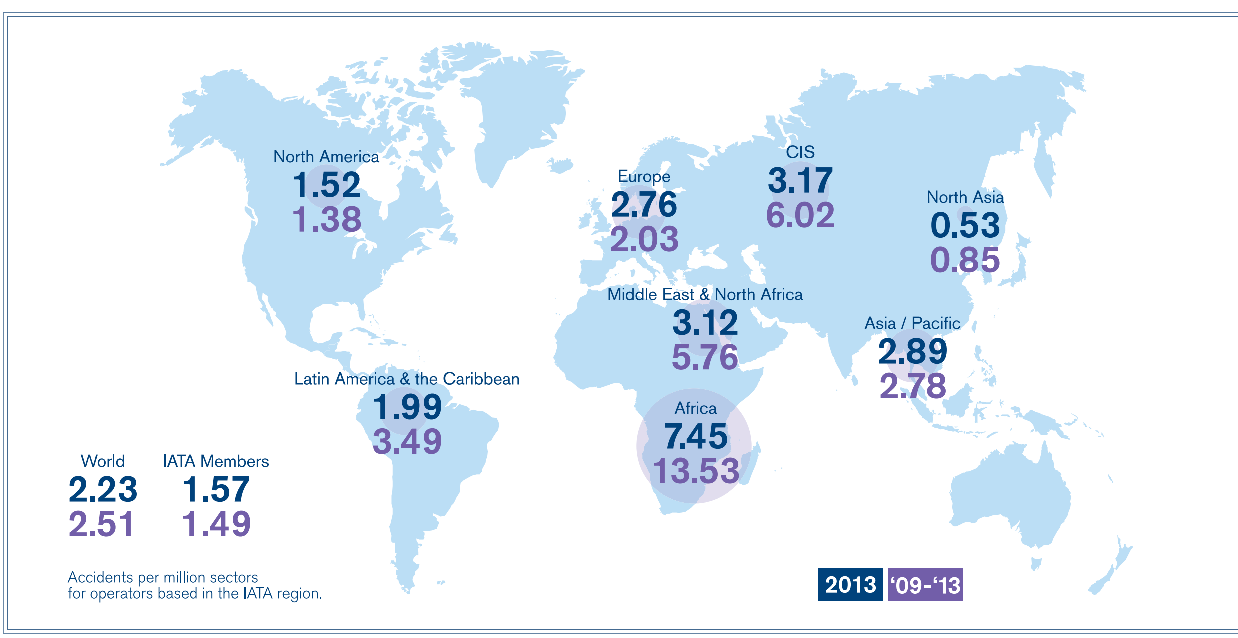
For example, if a Canadian-registered operator has an accident in Europe, this accident is counted as a "North American" accident as far as regional accident rates are concerned.

For a complete list of countries assigned per region, please consult **Annex 1**.

Western-built Jet Hull Loss Rate by IATA Region



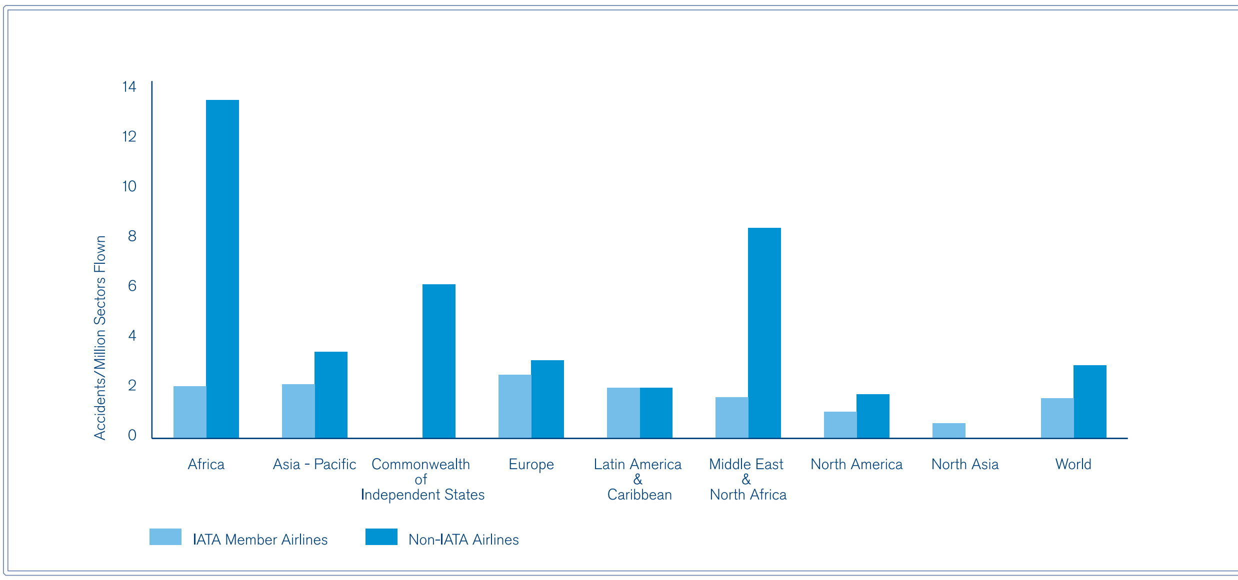
Total Accident Rate by IATA Region (Eastern-built and Western-built aircraft)



IATA Member Airlines vs. Non-Members - Total Accident Rate by Region

In an effort to better indicate the safety performance of IATA member airlines vs. non-members, IATA has determined the total accident rate for each region and globally. IATA member airlines outperformed non-members in every region except North Asia. IATA member performance was equal to non-members in Latin America and the Caribbean. The IATA member accident rate was 1.8 times less than for non-members in 2013.

2013 IATA Member Airlines vs. Non-Members



IOSA-Registered Airlines vs. Non-IOSA -Total Accident Rate by Region

In an effort to better indicate the safety performance of IOSA-registered airlines vs. non-IOSA, IATA has determined the total accident rate for each region and globally.

IOSA-registered airlines outperformed non-IOSA in every region except North Asia. The IOSA-registered airline accident rate was 2.5 times lower than for non-IOSA airlines in 2013.

2013 IOSA-Registered and Non-IOSA-Registered

"Ninety-five percent of loss of control in-flight accidents between 2009 and 2013 involved fatalities to passengers and/or crew."

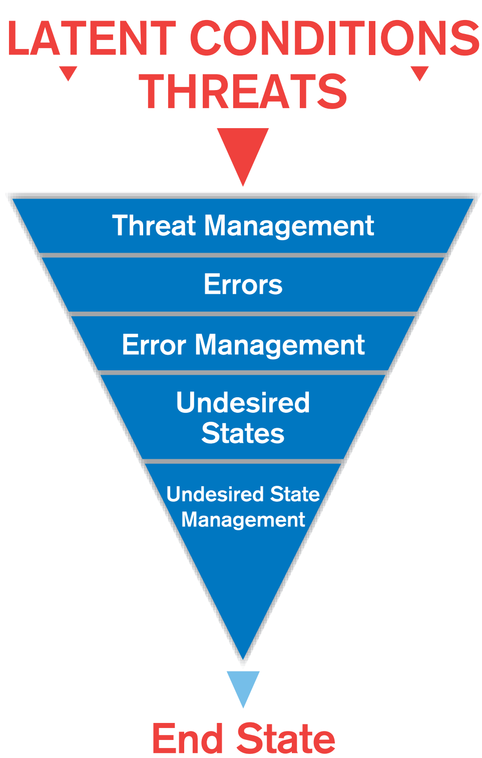
Section 4

In-Depth Accident Analysis 2009 to 2013

INTRODUCTION TO TEM FRAMEWORK

The Human Factors Research Project at The University of Texas in Austin developed Threat and Error Management (TEM) as a conceptual framework to interpret data obtained from both normal and abnormal operations. For many years, IATA has worked closely with the University of Texas Human Factors Research Team, the International Civil Aviation Organization (ICAO), member airlines and manufacturers to apply TEM to its many safety activities.

Threat and Error Management Framework



DEFINITIONS

Latent Conditions: Conditions present in the system before the accident, made evident by triggering factors. These often relate to deficiencies in organizational processes and procedures.

Threat: An event or error that occurs outside the influence of the flight crew, but which requires flight crew attention and management to properly maintain safety margins.

Flight Crew Error: An observed flight crew deviation from organizational expectations or crew intentions.

Undesired Aircraft State (UAS): A flight crew induced aircraft state that clearly reduces safety margins; a safety-compromising situation that results from ineffective threat/error management. An undesired aircraft state is recoverable.

End State: An end state is a reportable event. An end state is unrecoverable.

Distinction between "Undesired Aircraft State" and "End State": An unstable approach is recoverable. This is a UAS. A runway excursion is *unrecoverable*. Therefore, this is an End State.

ACCIDENT CLASSIFICATION SYSTEM

At the request of member airlines, manufacturers and other organizations involved in the Safety Report, IATA developed an accident classification system based on the Threat and Error Management (TEM) framework.

The purpose of the taxonomy is to:

- Acquire more meaningful data
- Extract further information/intelligence
- Formulate relevant mitigation strategies/ safety recommendations

Unfortunately, some accident reports do not contain sufficient information at the time of the analysis to adequately assess contributing factors. When an event cannot be properly classified due to a lack of information, it is classified under the insufficient information category. Where possible, these accidents have been assigned an End State. It should also be noted that the contributing factors that have been classified do not always reflect all the factors that played a part in an accident but rather those known at the time of the analysis. Hence, there is a need for Operators and States to improve their reporting cultures.

Important note: *In the in-depth analysis presented in Sections 4 through 6, the percentages shown with regards to contributing factors (e.g., % of threats and errors noted) are based on the number of accidents in each category. Accidents classified as "insufficient information" are excluded from this part of the analysis. The number of insufficient information accidents is noted at the bottom of each page.*

However, accidents classified as insufficient information are part of the overall statistics (e.g., % of accidents that were fatal or resulted in a hull loss).

Annex 1 contains definitions and detailed information regarding the types of accidents and aircraft types that are included in the Safety Report analysis as well as the breakdown of IATA regions.

The complete IATA TEM-based accident classification system for flight is presented in **Annex 2**.

ORGANIZATIONAL AND FLIGHT CREW-AIMED COUNTERMEASURES

Every year, the ACTF classifies accidents and, with the benefit of hindsight, determines actions or measures that could have been taken to prevent an accident. These proposed countermeasures can include overarching issues within an organization or a particular country, or involve performance of front line personnel, such as pilots or ground personnel.

Countermeasures are aimed at two levels:

- The first set is aimed at the operator or the state responsible for oversight: these countermeasures are based on activities, processes or systemic issues internal to the airline operation or state's oversight activities.
- The other set of countermeasures is aimed at the flight crews, to help them manage threats or their own errors while on the line.

Countermeasures for other personnel, such as air traffic controllers, ground crew, cabin crew or maintenance staff are important, but they are not considered at this time.

Each event was coded with potential countermeasures that, with the benefit of hindsight, could have altered the outcome of events. A statistical compilation of the top countermeasures is presented in Section 7 of this report.

ANALYSIS BY ACCIDENT CATEGORY AND REGION

- This section presents an in-depth analysis of 2009 to 2013 occurrences by accident category.
- Definitions of these categories can be found in **Annex 2**

Referring to these accident categories helps an operator to:

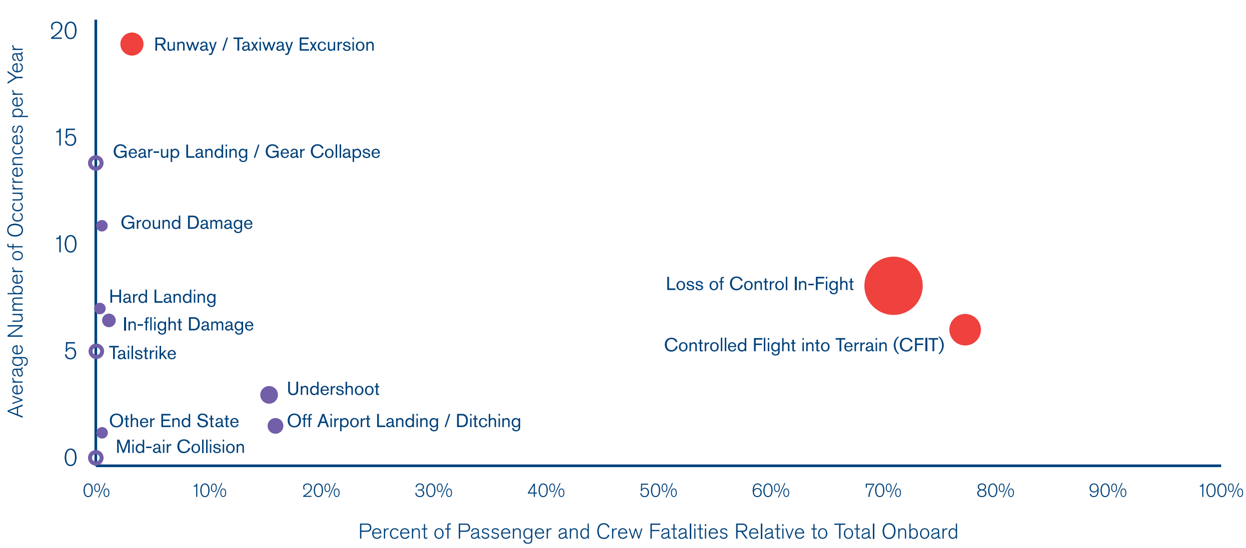
- Structure safety activities and set priorities
- Avoid “forgetting” key risk areas when a type of accident does not occur in a given year
- Provide resources for well-identified prevention strategies
- Address these categories both systematically and continuously within the airline’s safety management system

ACCIDENT FREQUENCY AND SURVIVABILITY

IATA has introduced the concept of high-risk accident categories into this year’s report. This is designed to expand beyond the traditional methods of high frequency as a single metric for prioritization of mitigation efforts and incorporate a metric for accident outcome related to survivability.

In the chart below, each accident category is plotted by the average number of occurrences per year and the percentage of fatalities relative to the total number of people on board. The bubble size increases as the absolute number of fatalities for the category increases; empty bubbles indicate no fatalities for that accident category. From this analysis Loss of Control In-flight, Controlled Flight into Terrain and Runway Excursions were identified as the top three high risk categories to be addressed by IATA.

World 2009-2013



Note: Circle size increases as total fatalities increase; circles with white centers indicate no fatalities.

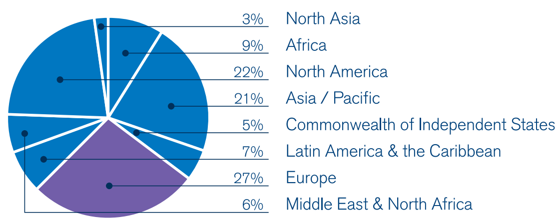
2013 Aircraft Accidents

81 Accidents

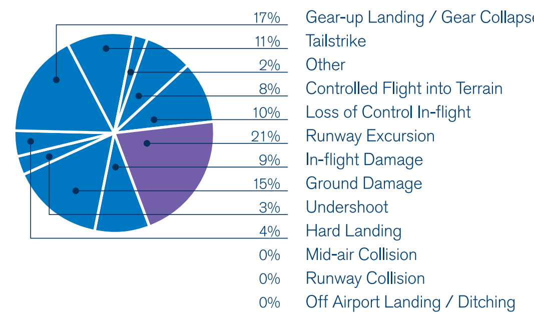
IATA Members	**35%**
Hull Losses	**40%**
Fatal	**20%**

78% Passenger	**18%** Cargo	**4%** Ferry	**47%** Jet	**53%** Turboprop

Breakdown per Operator Region

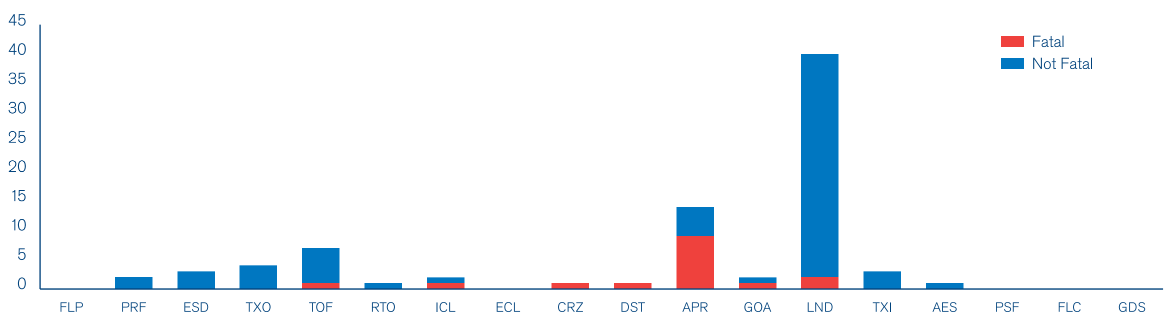


Breakdown per Accident Category



Accidents per Phase of Flight

See Annex 1 for detailed "Phase of Flight" definitions



Top Contributing Factors, 2013

See Annex 2 for "Contributing Factors" definitions

Latent Conditions (deficiencies in...)

40% Regulatory oversight
27% Safety management
14% Flight operations: training systems
10% Design

Threats

Environmental
24% Meteorology:
Wind/wind shear/gusty wind (53%* of these cases)
Poor visibility/IMC (27% *of these cases)
Thunderstorms (27%* of these cases)
13% Air traffic services
13% Ground-based navigation aids malfunctioning or not available

Airline
22% Aircraft malfunction:
Gear/tire (50% of all malfunctions)
Brakes (14% of all malfunctions)
10% Maintenance events
5% Ground events

Flight Crew Errors (relating to...)

29% Manual handling/flight controls
22% SOP adherence/cross-verification
Intentional non-compliance (50% of these cases)
Unintentional non-compliance (43% of these cases)
10% Failure to go around after destabilization during approach

Undesired Aircraft States

22% Long/floated/bounced/firm/off-centerline/crabbed landing
21% Vertical, lateral or speed deviations
10% Continued landing after unstable approach
8% Operation outside aircraft limitations
8% Unstable approach

Countermeasures

17% Monitor/cross-check
16% Overall crew performance
10% Contingency management
8% Leadership

Additional Classifications

20% Insufficient data for contributing factors

Relationships of Interest, 2013

Of the **14** accidents occurring during approach; **64%** involved one or more fatality. Of the fatal accidents during approach, **63%** were Controlled Flight into Terrain.

In **71%** of accidents where a long, floated, bounced, firm, off-centerline or crabbed landing was a contributing factor, flight crew manual handling errors were also noted as a factor.

Of these accidents, **40%** resulted in the aircraft being declared a hull loss.

Weak or inadequate regulatory oversight was noted as a contributing factor in **94%** of accidents where inadequate safety management at an operator was also noted.

Note: 16 accidents were not classified due to insufficient data; these accidents were removed from the count for the contributing factors and relationships of interest.
** The sum of the percentages may exceed 100% due to multiple contributing factors.*

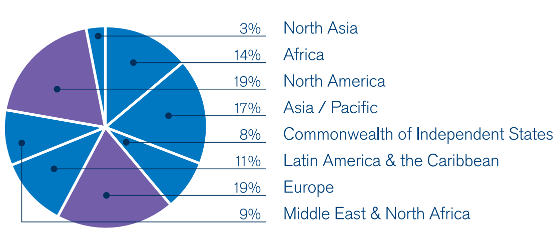
2009-2013
Aircraft Accidents

432 Accidents

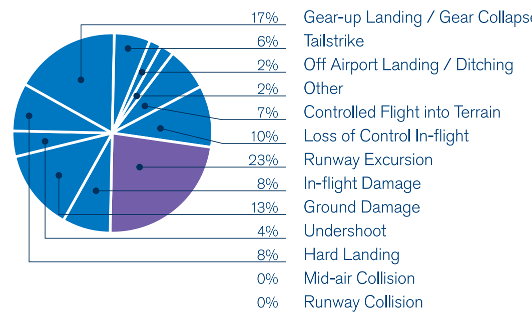
IATA Members	**30%**
Hull Losses	**42%**
Fatal	**22%**

78% Passenger	**19%** Cargo	**3%** Ferry	**56%** Jet	**44%** Turboprop

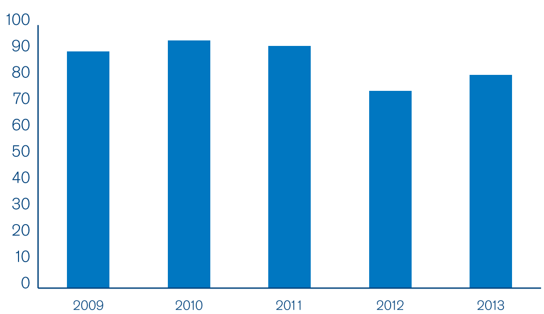
Breakdown per Operator Region



Breakdown per Accident Category

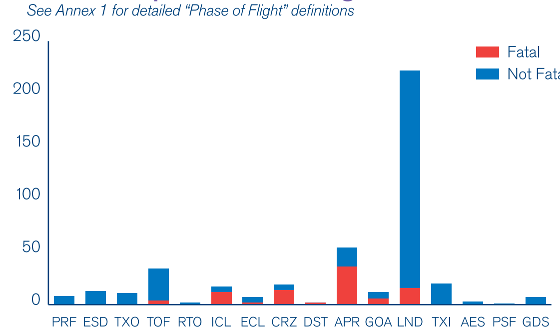


Accidents per Year



Accidents per Phase of Flight

See Annex 1 for detailed "Phase of Flight" definitions



Top Contributing Factors, 2009-2013

See Annex 2 for "Contributing Factors" definitions

Latent Conditions (deficiencies in...)

28% Regulatory oversight
22% Safety management
18% Flight operations:
Training systems (84% of these cases)
SOPs & Checking (48% of these cases)

Threats

Environmental
28% Meteorology:
Wind/wind shear/gusty wind (50%* of these cases)
Poor visibility/IMC (35%* of these cases)
Thunderstorms (22%* of these cases)
11% Ground-based navigation aids malfunctioning or not available

Airline
29% Aircraft malfunction:
Gear/tire (43% of all malfunctions)
Contained engine failure/powerplant malfunction (19% of all malfunctions)
10% Maintenance events
5% Ground events

Flight Crew Errors (relating to...)

28% Manual handling/flight controls
24% SOP adherence/cross-verification
Intentional non-compliance (59% of these cases)
Unintentional non-compliance (33% of these cases)
9% Failure to go around after destabilization during approach

Undesired Aircraft States

19% Long/floated/bounced/firm/off-centerline/crabbed landing
16% Vertical, lateral or speed deviations
10% Unstable approach
7% Operation outside aircraft limitations
6% Continued landing after unstable approach

Countermeasures

22% Overall crew performance
19% Monitor/cross-check
10% Contingency management
7% Leadership

Additional Classifications

11% Insufficient data for contributing factors

Relationships of Interest, 2009-2013

In **39%** of the accidents where manual handling by flight crew was a contributing factor, deficiencies in an operator's flight operations training systems were also noted. Improved monitoring or cross-checking by the crew was seen as capable of preventing the accident in **71%** of these events.

The lack of suitable navigation aids was a contributing factor in **41** accidents. Of these accidents, **51%** involved one or more fatalities and **73%** resulted in the aircraft being declared a hull loss.

Note: 46 accidents were not classified due to insufficient data; these accidents were removed from the count for the contributing factors and relationships of interest.
** The sum of the percentages may exceed 100% due to multiple contributing factors.*

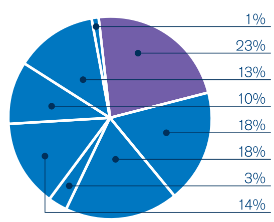
2009-2013
Fatal Aircraft Accidents

94 Accidents

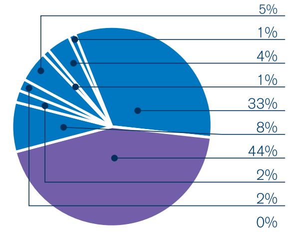
IATA Members	17%
Hull Losses	100%

65% Passenger	31% Cargo	4% Ferry	45% Jet	55% Turboprop

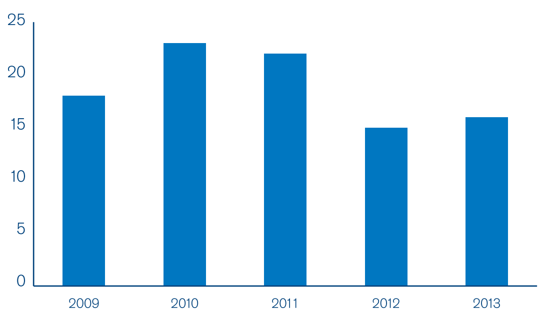
Breakdown per Operator Region



Breakdown per Accident Category

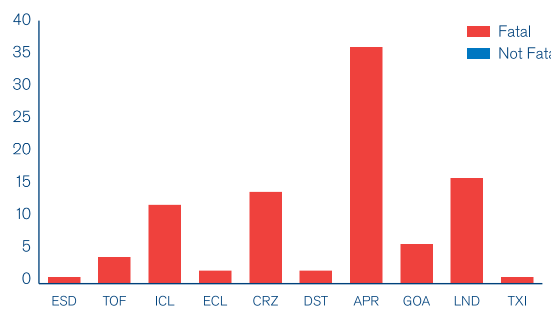


Accidents per Year



Accidents per Phase of Flight

See Annex 1 for detailed "Phase of Flight" definitions



Top Contributing Factors, 2009-2013

See Annex 2 for "Contributing Factors" definitions

Latent Conditions
(deficiencies in...)

45% Regulatory oversight
38% Safety management
23% Flight operations: training systems
20% Technology and equipment

Threats

Environmental

45% Meteorology:
Poor visibility/IMC
(64% of these cases)
Wind/wind shear/gusty wind
(22% of these cases)
26% Ground-based navigation aids malfunctioning or not available
13% Lack of visual reference

Airline

31% Aircraft malfunction:
Contained engine failure/ powerplant malfunction
(48% of all malfunctions)
Fire/smoke (cockpit/cabin/ cargo)
(28% of all malfunctions)
9% Maintenance events
8% Operational pressure

Flight Crew Errors
(relating to...)

40% SOP adherence/cross-verification
Intentional non-compliance
(72% of these cases)
Unintentional non-compliance
(28% of these cases)
33% Manual handling/flight controls
15% Callouts
14% Pilot-to-pilot communication

Undesired Aircraft States

36% Vertical, lateral or speed deviations
18% Controlled flight towards terrain
16% Operation outside of aircraft limitations
13% Unstable approach
11% Unnecessary weather penetration

Countermeasures

41% Overall crew performance
31% Monitor/cross-check
16% Contingency management
16% Leadership

Additional Classifications

10% Insufficient data for contributing factors

Relationships of Interest, 2009-2013

38% of fatal accidents occurred during the approach phase of flight. Of these, **56%** were due to controlled flight into terrain and **63%** involved flight crew vertical, lateral or speed deviations.

Deficiencies in the operator's safety management were noted in **79%** of events where inadequate standard operating procedures for flight crew were noted as a factor.

Note: Nine accidents were not classified due to insufficient data; these accidents were removed from the count for the contributing factors and relationships of interest.

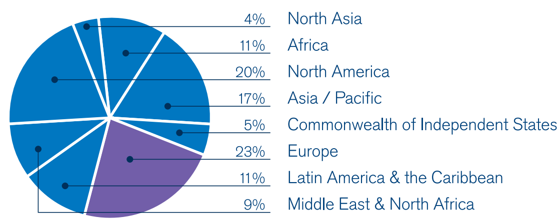
2009-2013 Non-Fatal Aircraft Accidents

338 Accidents

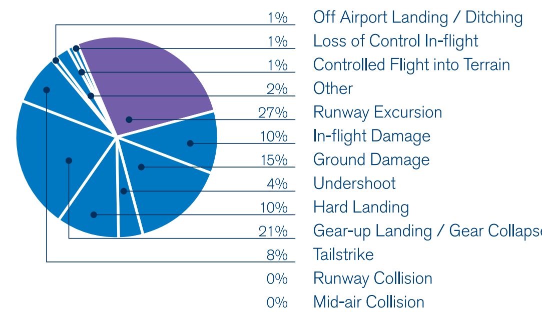
IATA Members	33%
Hull Losses	26%

81% Passenger	16% Cargo	3% Ferry	59% Jet	41% Turboprop

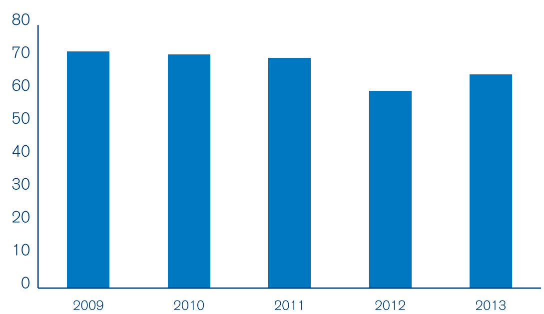
Breakdown per Operator Region



Breakdown per Accident Category

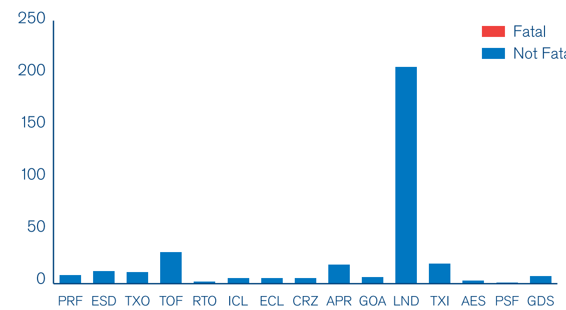


Accidents per Year



Accidents per Phase of Flight

See Annex 1 for detailed "Phase of Flight" definitions



Top Contributing Factors, 2009-2013

See Annex 2 for "Contributing Factors" definitions

Latent Conditions (deficiencies in...)

- **24%** Regulatory oversight
- **18%** Safety management
- **13%** Flight operations: training systems
- **8%** Maintenance operations

Threats

Environmental

- **23%** Meteorology:
  - Wind/wind shear/gusty wind (65% of these cases)
  - Thunderstorms (25% of these cases)
- **9%** Contaminated runway/taxiway
- **7%** Ground-based navigation aids malfunctioning or not available

Airline

- **29%** Aircraft malfunction:
  - Gear/tire (55% of all malfunctions)
  - Contained engine failure/powerplant malfunction (11% of all malfunctions)
- **11%** Maintenance events
- **7%** Ground events

Flight Crew Errors (relating to...)

- **26%** Manual handling/flight controls
- **20%** SOP adherence/cross-verification
  - Intentional non-compliance (50% of these cases)
  - Unintentional non-compliance (36% of these cases)
- **9%** Failure to go around after destabilization during approach

Undesired Aircraft States

- **23%** Long/floated/bounced/firm/off-centerline/crabbed landing
- **11%** Vertical, lateral or speed deviations
- **9%** Unstable approach
- **7%** Loss of aircraft control while on the ground
- **7%** Continued landing after unstable approach

Countermeasures

- **17%** Overall crew performance
- **16%** Monitor/cross-check
- **9%** Contingency management
- **5%** Taxiway/runway management
- **5%** Leadership

Additional Classifications

- **11%** Insufficient data for contributing factors

Relationships of Interest, 2009-2013

Runway or taxiway excursions were the most frequent non-fatal accident category representing **27%** of all non-fatal accidents. Of these accidents, **44%** involved a long, floated, bounced, firm, off-centerline or crabbed landing.

Improvements in flight crew monitoring and cross checking were noted as a method for preventing the accident in **60%** of events involving noted deficiencies in flight crew training.

Note: 37 accidents were not classified due to insufficient data; these accidents were removed from the count for the contributing factors and relationships of interest.

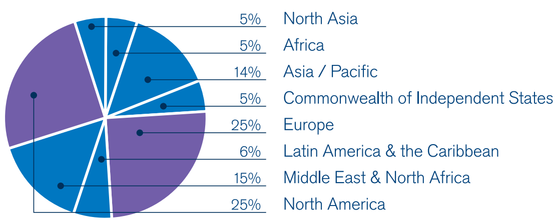
2009-2013 IOSA Aircraft Accidents

174 Accidents

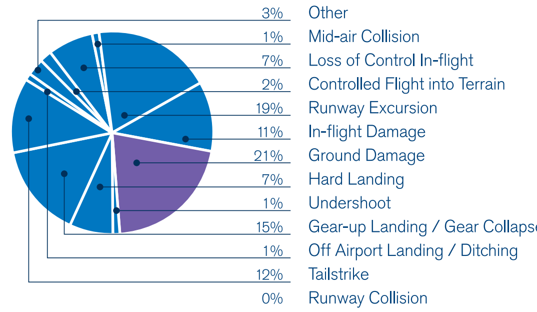
IATA Members	**74%**
Hull Losses	**22%**
Fatal	**11%**

87% Passenger	**10%** Cargo	**3%** Ferry	**79%** Jet	**21%** Turboprop

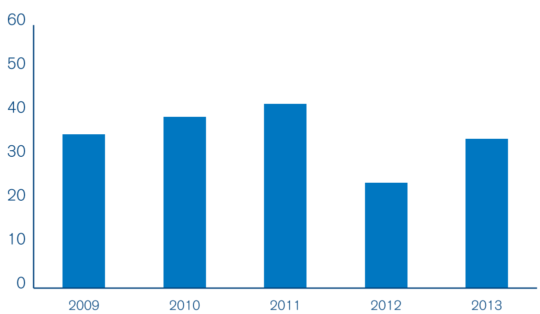
Breakdown per Operator Region



Breakdown per Accident Category

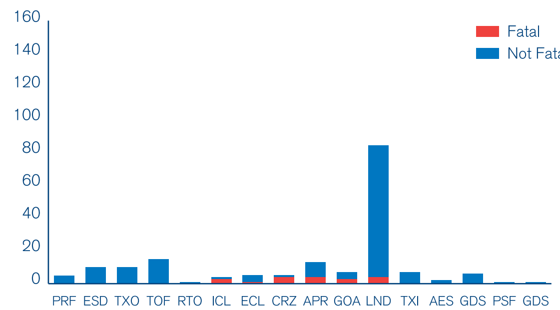


Accidents per Year



Accidents per Phase of Flight

See Annex 1 for detailed "Phase of Flight" definitions



Top Contributing Factors, 2009-2013

See Annex 2 for "Contributing Factors" definitions

Latent Conditions (deficiencies in...)

17% Regulatory oversight
15% Flight operations: training systems
10% Safety management
9% Maintenance operations

Threats

Environmental
24% Meteorology:
Wind/wind shear/gusty wind (59% of these cases)
Thunderstorms (26% of these cases)
9% Air traffic services
8% Contaminated runway/ taxiway - poor braking action

Airline
30% Aircraft malfunction:
Gear/tire (48% of all malfunctions)
Fire/smoke (cockpit/cabin/ cargo) (21% of all malfunctions)
14% Maintenance events
9% Ground events

Flight Crew Errors (relating to...)

26% Manual handling/flight controls
20% SOP adherence/cross-verification
Unintentional non-compliance (48% of these cases)
Intentional non-compliance (45% of these cases)
9% Failure to go around after destabilization during approach

Undesired Aircraft States

22% Long/floated/bounced/ firm/off-centerline/ crabbed landing
12% Vertical, lateral or speed deviations
9% Operation outside of aircraft limitations
9% Unstable approach
6% Loss of aircraft control while on the ground

Countermeasures

17% Monitor/cross-check
16% Overall crew performance
9% Contingency management
7% Leadership
5% Communication environment

Additional Classifications

7% Insufficient data for contributing factors

Relationships of Interest, 2009-2013

The most frequent category of accident for IOSA-registered operators was ground damage. Of these accidents, **35%** involved a collision during taxi.

Of fatal accidents for operators on the IOSA registry, **58%** were due to loss of control in-flight. In **64%** of these events, improvements in overall crew performance are believed to have prevented the accident.

Note: 12 accidents were not classified due to insufficient data; these accidents were removed from the count for the contributing factors and relationships of interest.

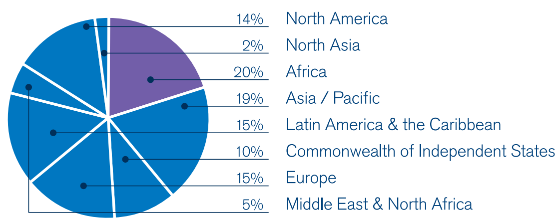
2009-2013 Non-IOSA Aircraft Accidents

258 Accidents

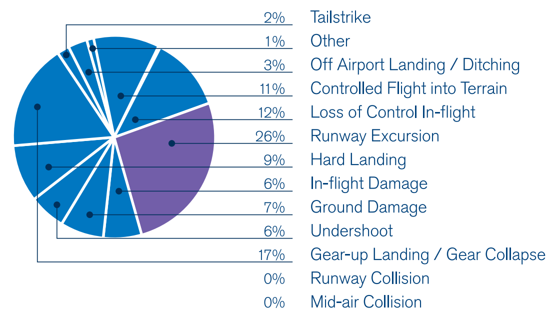
IATA Members	0%
Hull Losses	55%
Fatal	29%

71% Passenger	**26%** Cargo	**3%** Ferry	**40%** Jet	**60%** Turboprop

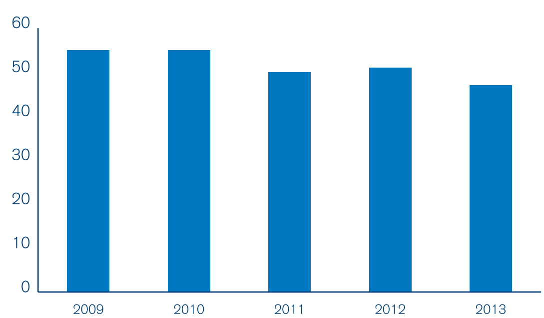
Breakdown per Operator Region



Breakdown per Accident Category

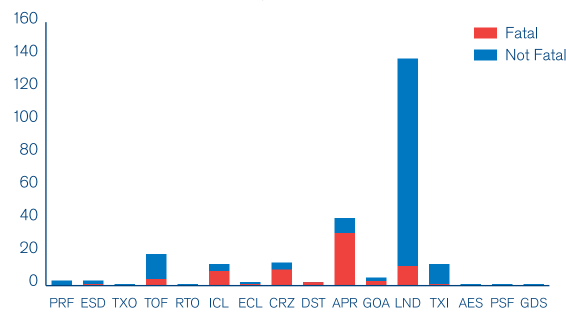


Accidents per Year



Accidents per Phase of Flight

See Annex 1 for detailed "Phase of Flight" definitions



Top Contributing Factors, 2009-2013

See Annex 2 for "Contributing Factors" definitions

Latent Conditions (deficiencies in...)

37% Regulatory oversight
31% Safety management
15% Flight operations: training systems
12% Flight operations: SOPs & checking

Threats

Environmental
31% Meteorology:
Poor visibility/IMC (48% of these cases)
Wind/wind shear/gusty wind (45% of these cases)
15% Ground-based navigation aids malfunctioning or not available

Airline
29% Aircraft malfunction:
Gear/tire (39% of all malfunctions)
Contained engine failure/ powerplant malfunction (26% of all malfunctions)
8% Maintenance events

Flight Crew Errors (relating to...)

29% Manual handling/flight controls
27% SOP adherence/cross-verification
Intentional non-compliance (67% of these cases)
Unintentional non-compliance (24% of these cases)
8% Failure to go around after destabilization during approach

Undesired Aircraft States

19% Vertical, lateral or speed deviations
18% Long/floated/bounced/ firm/off-centerline/ crabbed landing
10% Unstable approach
8% Continued landing after unstable approach
6% Controlled flight towards terrain

Countermeasures

27% Overall crew performance
21% Monitor/cross-check
11% Contingency management
7% Leadership

Additional Classifications

13% Insufficient data for contributing factors

Relationships of Interest, 2009-2013

The highest number of fatal accidents for operators not on the IOSA registry occurred during approach. Of these fatal approach accidents, **60%** were due to controlled flight into terrain and **69%** cited weak regulatory oversight of operators.

In **54%** of accidents where intentional deviations from standard operating procedures were a contributing factor to the accident, vertical, lateral or speed flight crew deviations were also noted.

Note: 34 accidents were not classified due to insufficient data; these accidents were removed from the count for the contributing factors and relationships of interest.

Controlled Flight into Terrain

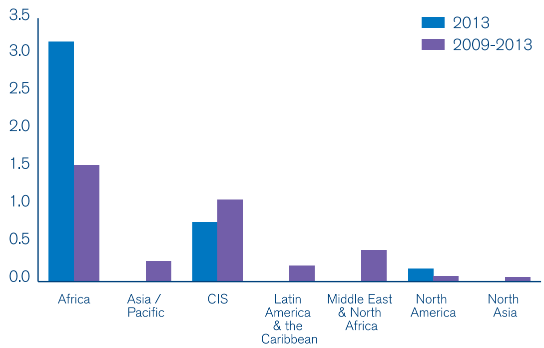
2013 6 Accidents
2009-2013 31 Accidents

	2013	'09-'13
IATA Members	33%	10%
Hull Losses	100%	100%
Fatal	100%	94%
Accident Rate	0.17	0.18

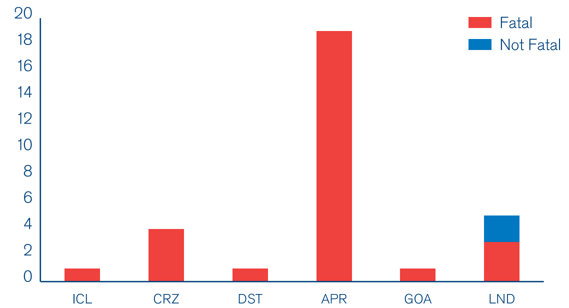
	Passenger	Cargo	Ferry	Jet	Turboprop
2013	33%	50%	17%	50%	50%
2009-2013	61%	32%	7%	39%	61%

Accident Rates per Operator Region

Accidents per million sectors flown for all aircraft types

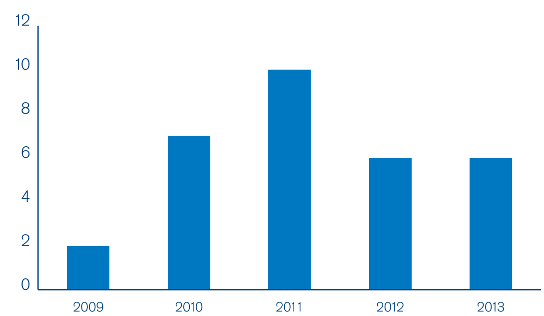


Accidents per Phase of Flight, 2009-2013

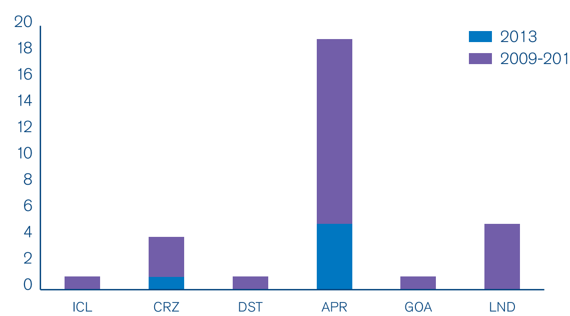


See Annex 1 for "Phase of Flight" definitions

Accidents per Year



Accidents per Phase of Flight



Top Contributing Factors, 2009-2013

See Annex 2 for "Contributing Factors" definitions

Latent Conditions (deficiencies in...)

- **74%** Regulatory oversight
- **59%** Technology and equipment
- **41%** Safety management
- **15%** Flight operations: SOPs & checking

Threats

Environmental

- **52%** Ground-based nav aid malfunction or not available
- **52%** Poor visibility/IMC

Airline

None noted.

Flight Crew Errors (relating to...)

- **48%** SOP adherence/SOP cross-verification:
  Intentional non-compliance (85%* of these cases)
  Unintentional non-compliance (23%* of these cases)
- **19%** Manual handling/flight controls
- **19%** Callouts

Undesired Aircraft States

- **52%** Vertical, lateral or speed deviations
- **52%** Controlled flight towards terrain
- **19%** Unnecessary weather penetration

Countermeasures

- **48%** Monitor/cross-check
- **44%** Overall crew performance
- **19%** Communication environment
- **19%** Contingency management

Additional Classifications

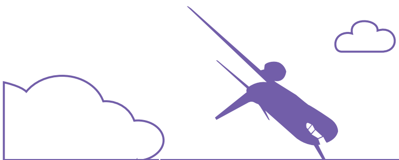
- **13%** Insufficient data for contributing factors

Relationships of Interest, 2009-2013

Weak regulatory oversight was noted as a factor in **85%** of cases where the lack of a precision approach was a contributing factor to the accident.

Intentional deviations from standard operating procedures were noted in **64%** of accidents where vertical, lateral or speed deviations were noted as a factor.

Note: Four accidents were not classified due to insufficient data; these accidents were removed from the count for the contributing factors and relationships of interest.
** The sum of the percentages may exceed 100% due to multiple contributing factors.*



Loss of Control In-flight

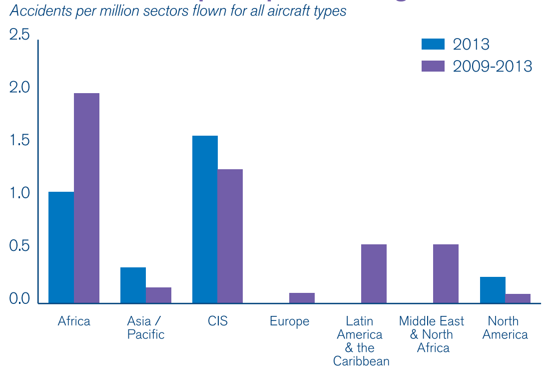
2013 8 Accidents
2009-2013 41 Accidents

	2013	'09-'13
IATA Members	13%	22%
Hull Losses	100%	95%
Fatal	100%	95%
Accident Rate	0.22	0.24

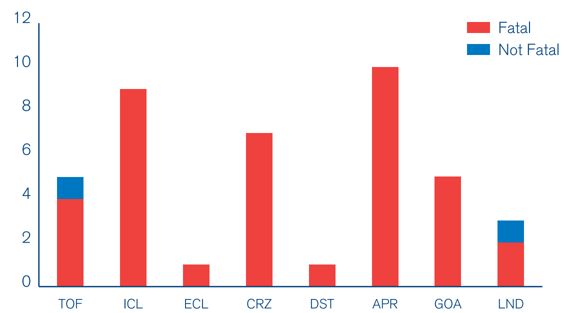
	Passenger	Cargo	Ferry	Jet	Turboprop
2013	75%	25%	0%	38%	62%
2009-2013	71%	29%	0%	41%	59%

Accident Rates per Operator Region

Accidents per million sectors flown for all aircraft types

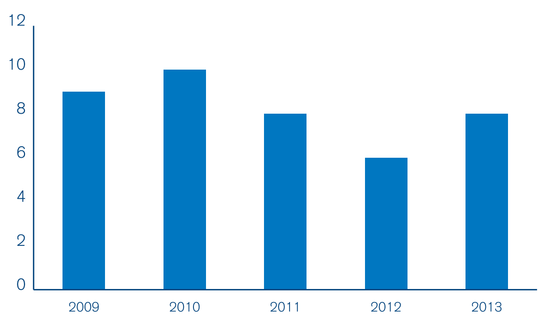


Accidents per Phase of Flight, 2009-2013

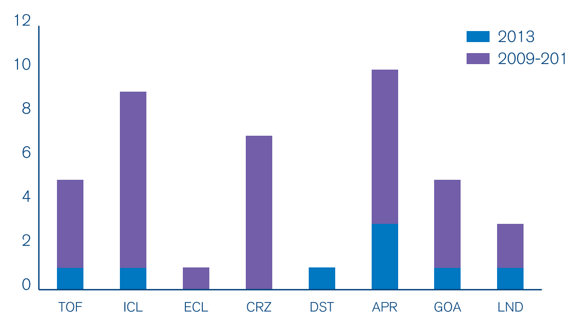


See Annex 1 for "Phase of Flight" definitions

Accidents per Year



Accidents per Phase of Flight



Top Contributing Factors, 2009-2013

See Annex 2 for "Contributing Factors" definitions

Latent Conditions (deficiencies in...)

37% Safety management
34% Flight operations:
Training systems (24% of these cases)
SOPs & checking (18% of these cases)
32% Regulatory oversight

Threats

Environmental
37% Meteorology:
Icing conditions (40%* of these cases)
Poor visibility/IMC (33%* of these cases)
Wind/Windshear/Gusty wind (33%* of these cases)
37% Lack of visual reference

Airline
42% Aircraft malfunction:
Contained engine failure/powerplant malfunction (63% of these cases)
16% Operational pressure
11% Maintenance events

Flight Crew Errors (relating to...)

42% Manual handling/flight controls
39% SOP adherence/SOP cross-verification:
Intentional non-compliance (60% of these cases)
Unintentional non-compliance (33% of these cases)
16% Callouts

Undesired Aircraft States

32% Operation outside aircraft limitations
32% Vertical/lateral speed deviation
16% Unstable approach
13% Unnecessary weather penetration
8% Flight controls automation

Countermeasures

42% Overall crew performance
24% Monitor/cross-check
18% Contingency management
16% Automation management
16% Captain should show leadership

Additional Classifications

7% Insufficient data for contributing factors

Relationships of Interest, 2009-2013

56% of accidents occurring during the initial climb involved a contained engine failure. **80%** of these involved turboprop aircraft.

Note: Three accidents were not classified due to insufficient data; these accidents were removed from the count for the contributing factors and relationships of interest.
** The sum of the percentages may exceed 100% due to multiple contributing factors.*

Mid-Air Collision

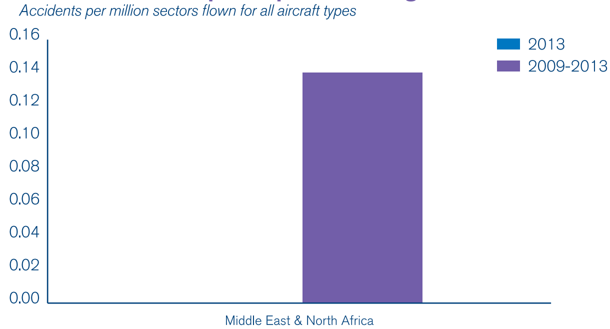
2013 0 Accident
2009-2013 1 Accident

	2013	'09-'13
IATA Members	N/A	100%
Hull Losses	N/A	0%
Fatal	N/A	0%
Accident Rate	N/A	0.01

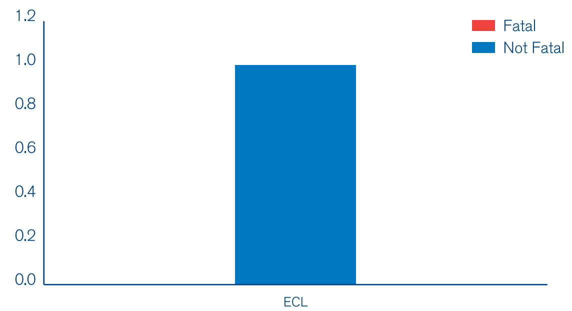
	Passenger	Cargo	Ferry	Jet	Turboprop
2013	N/A	N/A	N/A	N/A	N/A
2009-2013	100%	0%	0%	100%	0%

Accident Rates per Operator Region

Accidents per million sectors flown for all aircraft types

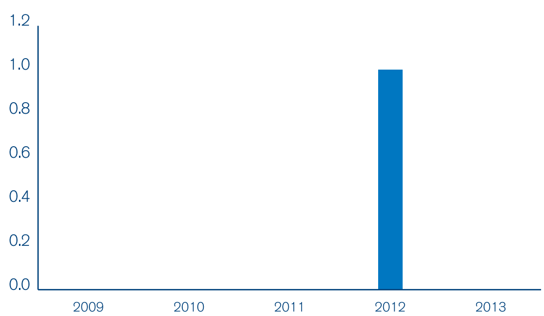


Accidents per Phase of Flight, 2009-2013

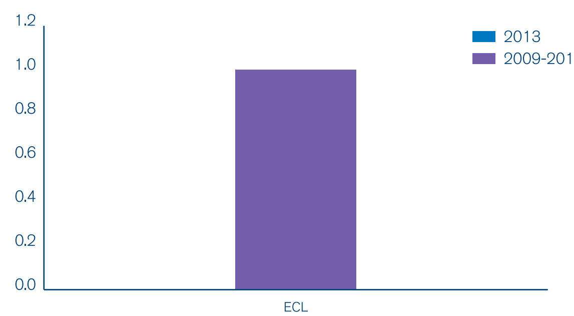


See Annex 1 for "Phase of Flight" definitions

Accidents per Year



Accidents per Phase of Flight



Top Contributing Factors, 2009-2013

See Annex 2 for "Contributing Factors" definitions

Latent Conditions (deficiencies in...)	Threats	Flight Crew Errors (relating to...)	Undesired Aircraft States	Countermeasures
Note: Given that one accident does not provide a complete picture of the status of a category of accident, IATA does not publish contributing factors or relationships of interest.	Environmental Airline			Additional Classifications

Relationships of Interest, 2009-2013

Runway Excursion

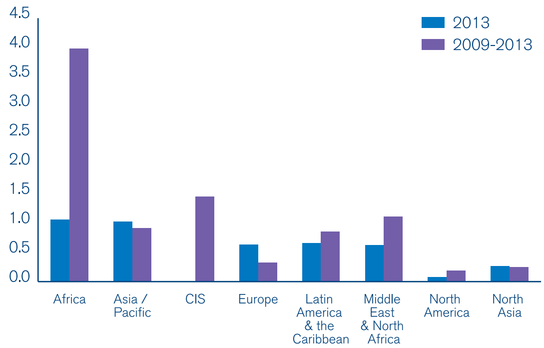
2013 — 17 Accidents
2009-2013 — 98 Accidents

	2013	'09-'13
IATA Members	29%	26%
Hull Losses	35%	43%
Fatal	6%	7%
Accident Rate	0.47	0.57

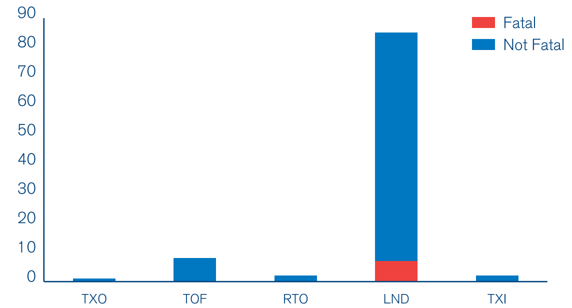
	Passenger	Cargo	Ferry	Jet	Turboprop
2013	88%	12%	0%	35%	65%
2009-2013	85%	13%	2%	53%	47%

Accident Rates per Operator Region

Accidents per million sectors flown for all aircraft types

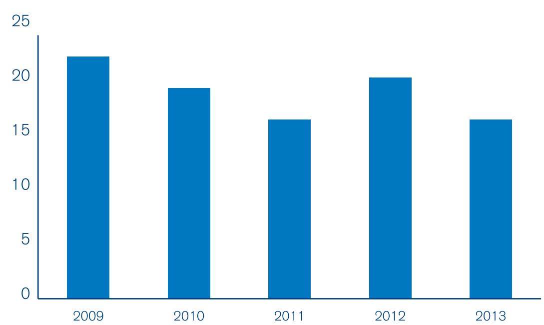


Accidents per Phase of Flight, 2009-2013

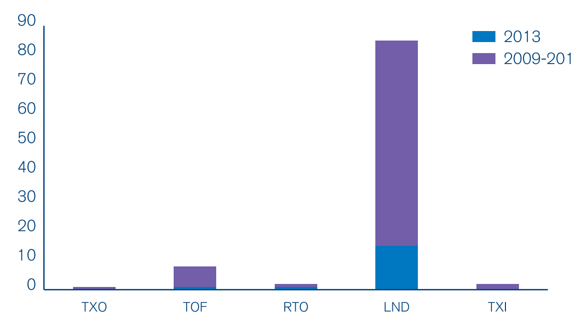


See Annex 1 for "Phase of Flight" definitions

Accidents per Year



Accidents per Phase of Flight



Top Contributing Factors, 2009-2013

See Annex 2 for "Contributing Factors" definitions

Latent Conditions (deficiencies in...)

- **34%** Regulatory oversight
- **26%** Safety management
- **18%** Flight operations:
  Training systems (94% of these cases)
  SOPs & checking (44% of these cases)

Threats

Environmental
- **39%** Meteorology:
  Wind/windshear/gusty wind (59% of these cases)
  Thunderstorms (35% of these cases)
- **32%** Contaminated runway/taxiway

Airline
- **20%** Aircraft malfunction:
  Brakes (24% of these cases)
  Contained engine failure/powerplant malfunction (24% of these cases)
  Gear/tire (24% of these cases)

Flight Crew Errors (relating to...)

- **39%** Manual handling/flight controls
- **23%** SOP adherence/SOP cross-verification:
  Intentional non-compliance (70% of these cases)
  Unintentional non-compliance (25% of these cases)
- **14%** Failure to go around after destabilized approach

Undesired Aircraft States

- **45%** Long/floated/bounced/firm/off-center/crabbed landing
- **17%** Loss of aircraft control while on the ground
- **16%** Unstable approach
- **14%** Continued landing after unstable approach
- **13%** Vertical/lateral/speed deviation

Countermeasures

- **29%** Overall crew performance
- **24%** Monitor/cross-check
- **13%** Contingency management
- **9%** Taxiway/runway management
- **7%** Leadership

Additional Classifications

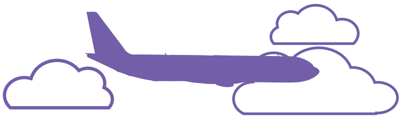
- **11%** Insufficient data for contributing factors

Relationships of Interest, 2009-2013

In **61%** of runway excursions where crews landed on a contaminated runway, the aircraft landed long, bounced, firm, off-centerline or crabbed. **55%** of these resulted in the aircraft being declared a hull loss.

Flight crew manual control of the aircraft was a factor in **50%** of runway excursions where strong or shifting winds was also noted.

Note: 11 accidents were not classified due to insufficient data; these accidents were removed from the count for the contributing factors and relationships of interest.



In-flight Damage

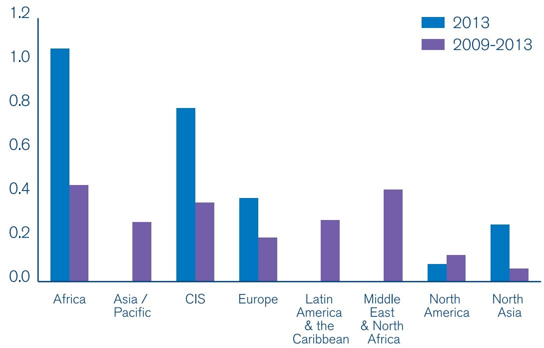
2013 — 7 Accidents
2009-2013 — 34 Accidents

	2013	'09-'13
IATA Members	**57%**	**44%**
Hull Losses	**14%**	**15%**
Fatal	**0%**	**6%**
Accident Rate	**0.19**	**0.20**

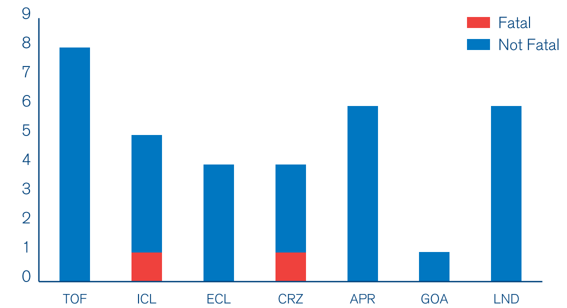
	Passenger	Cargo	Ferry	Jet	Turboprop
2013	**71%**	**29%**	**0%**	**71%**	**29%**
2009-2013	**74%**	**24%**	**3%**	**79%**	**21%**

Accident Rates per Operator Region

Accidents per million sectors flown for all aircraft types

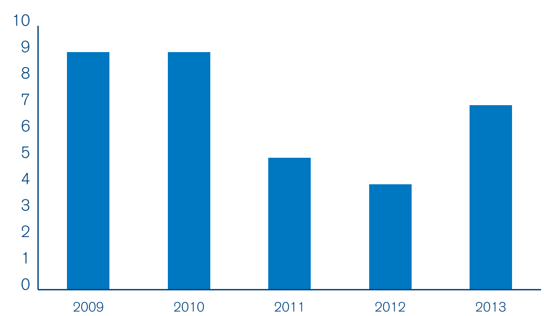


Accidents per Phase of Flight, 2009-2013

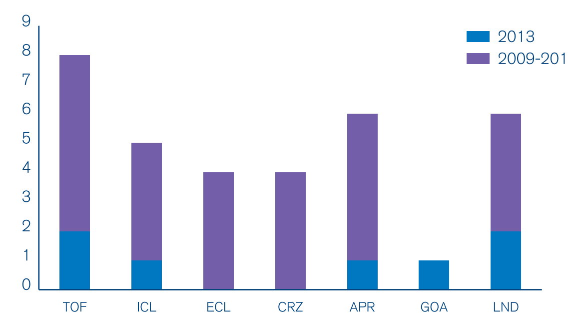


See Annex 1 for "Phase of Flight" definitions

Accidents per Year



Accidents per Phase of Flight



Top Contributing Factors, 2009-2013

See Annex 2 for "Contributing Factors" definitions

Latent Conditions (deficiencies in...)

- **18%** Regulatory oversight
- **15%** Maintenance Operations: SOPs & checking
- **9%** Safety management

Threats

Environmental
- **35%** Wildlife/birds/foreign object
- **21%** Meteorology: Thunderstorms (71% of these cases)

Airline
- **38%** Aircraft malfunction: Extensive/uncontained engine failure (46% of these cases)
- **21%** Maintenance events

Flight Crew Errors (relating to...)

- **12%** SOP adherence/SOP cross-verification: Intentional non-compliance (50% of these cases)

Undesired Aircraft States

- **9%** Vertical, lateral or speed deviations

Countermeasures

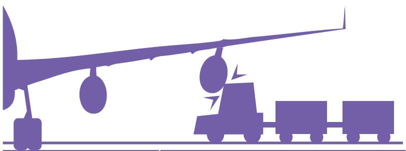
- **6%** Contingency management

Additional Classifications

No additional classifications

Relationships of Interest, 2009-2013

Deficiencies in maintenance standard operating procedures and checking were noted as a factor in **80%** of accidents where maintenance was an issue.



Ground Damage

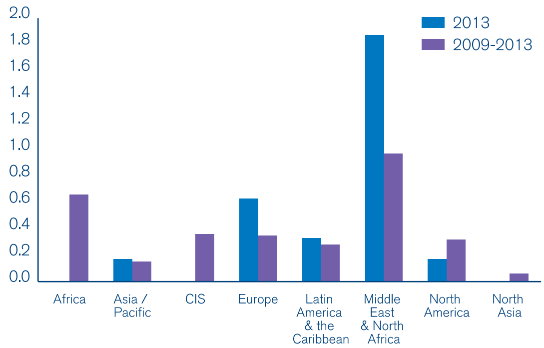
2013 12 Accidents
2009-2013 54 Accidents

	2013	'09-'13
IATA Members	42%	43%
Hull Losses	8%	11%
Fatal	0%	4%
Accident Rate	0.33	0.31

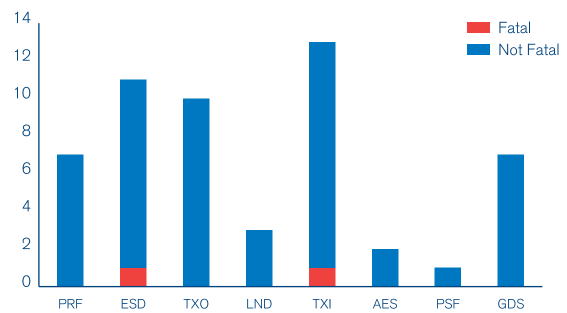
	Passenger	Cargo	Ferry	Jet	Turboprop
2013	92%	8%	0%	58%	42%
2009-2013	92%	4%	4%	63%	37%

Accident Rates per Operator Region

Accidents per million sectors flown for all aircraft types

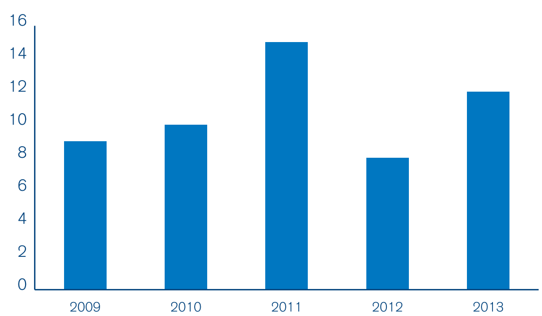


Accidents per Phase of Flight, 2009-2013

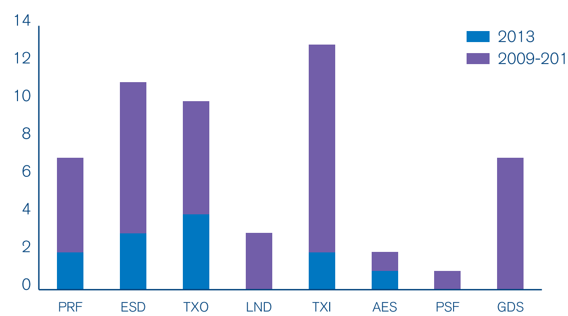


See Annex 1 for "Phase of Flight" definitions

Accidents per Year



Accidents per Phase of Flight



Top Contributing Factors, 2009-2013

See Annex 2 for "Contributing Factors" definitions

Latent Conditions (deficiencies in...)

20% Regulatory oversight
12% Ground operations:
SOPs & checking
(83% of these cases)
Training systems
(50% of these cases)
12% Safety management
6% Management decisions

Threats

Environmental
16% Airport facilities:
Inadequate overrun area
(50% of these cases)
Poor/faint markings/signs or runway/taxiway closure
(38% of these cases)
14% Air traffic services

Airline
37% Ground events:
20% Aircraft malfunction:
Fire/smoke (cockpit/cabin/cargo)
(70% of these cases)
Brakes
(20% of these cases)
8% Maintenance events

Flight Crew Errors (relating to...)

14% SOP adherence/SOP cross-verification:
Intentional non-compliance
(43% of these cases)
Unintentional non-compliance
(29% of these cases)
10% Crew to external communications errors
8% Ground crew
8% Ground navigation

Undesired Aircraft States

16% Ramp movements
10% Loss of aircraft control while on the ground

Countermeasures

12% Overall crew performance
12% Taxiway/ runway management
8% Monitor/cross-check

Additional Classifications

No additional classifications

Relationships of Interest, 2009-2013

In **57%** of accidents where inadequate air traffic control was noted as a factor, crew management of the taxi was noted to have been able to prevent the occurrence.

Undershoot

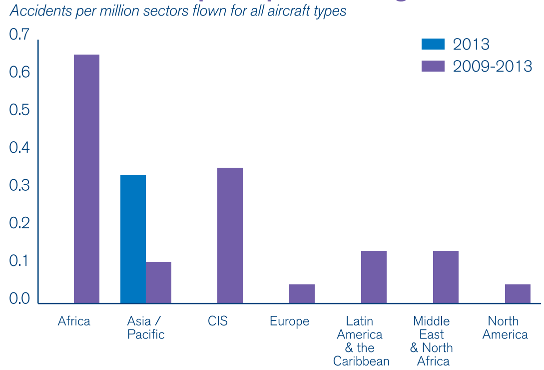
2013	2 Accidents
2009-2013	16 Accidents

	2013	'09-'13
IATA Members	0%	6%
Hull Losses	100%	81%
Fatal	0%	25%
Accident Rate	0.06	0.09

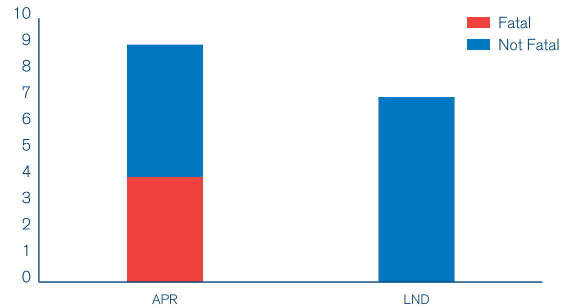
	Passenger	Cargo	Ferry	Jet	Turboprop
2013	**100%**	**0%**	**0%**	**50%**	**50%**
2009-2013	**62.5%**	**37.5%**	**0%**	**56%**	**44%**

Accident Rates per Operator Region

Accidents per million sectors flown for all aircraft types

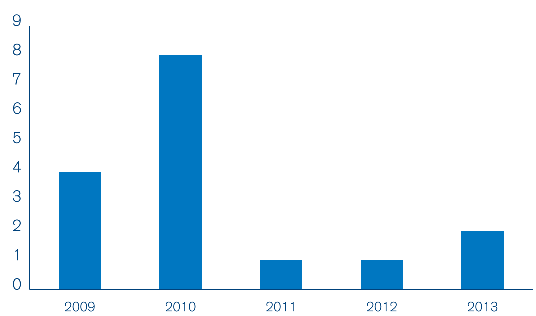


Accidents per Phase of Flight, 2009-2013

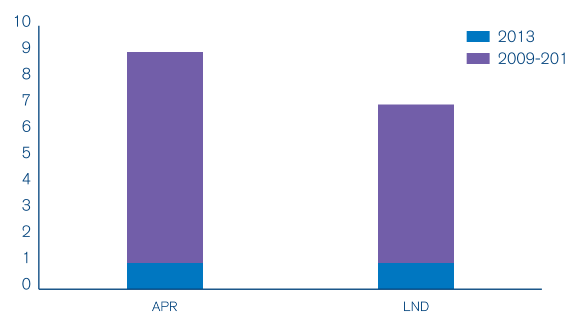


See Annex 1 for "Phase of Flight" definitions

Accidents per Year



Accidents per Phase of Flight



Top Contributing Factors, 2009-2013

See Annex 2 for "Contributing Factors" definitions

Latent Conditions (deficiencies in...)

56% Regulatory oversight
56% Safety management
38% Flight operations:
Training systems (67% of these cases)
SOPs & checking (50% of these cases)
19% Change management

Threats

Environmental
56% Meteorology:
Poor visibility/IMC (56%* of these cases)
Wind/windshear/gusty wind (56%* of these cases)
44% Ground-based nav aid malfunction or not available

Airline
None noted.

Flight Crew Errors (relating to...)

50% SOP adherence/SOP cross-verification:
Intentional non-compliance (88% of these cases)
44% Manual handling/flight controls
19% Failure to go around after destabilized approach

Undesired Aircraft States

75% Vertical, lateral or speed deviations
31% Unstable approach
19% Continued landing after unstable approach

Countermeasures

56% Overall crew performance
31% Monitor/cross-check
19% Contingency management
19% Leadership

Additional Classifications

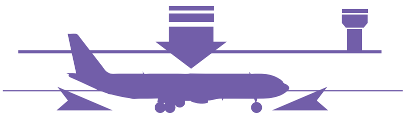
No additional classifications

Relationships of Interest, 2009-2013

In **88%** of accidents where the lack of adequate ground-based navigation aids was noted as a factor, flight crews intentionally deviated from standard operating procedures.

Weak safety management by the operator was noted as a factor in **77%** of accidents where deviations from the flight path or speed were also a factor.

** The sum of the percentages may exceed 100% due to multiple contributing factors.*



Hard Landing

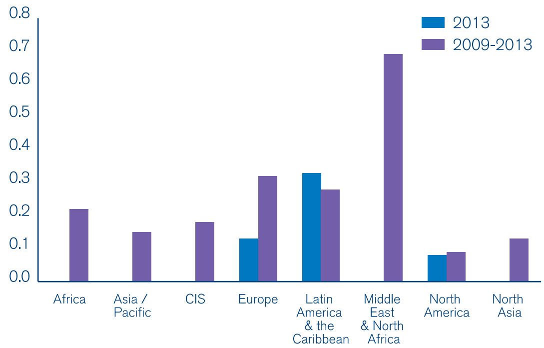
2013 — 3 Accidents
2009-2013 — 35 Accidents

	2013	'09-'13
IATA Members	0%	34%
Hull Losses	100%	31%
Fatal	0%	3%
Accident Rate	0.08	0.20

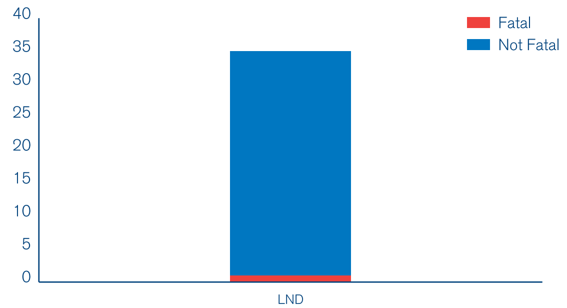
	Passenger	Cargo	Ferry	Jet	Turboprop
2013	67%	0%	33%	33%	67%
2009-2013	77%	20%	3%	71%	29%

Accident Rates per Operator Region

Accidents per million sectors flown for all aircraft types

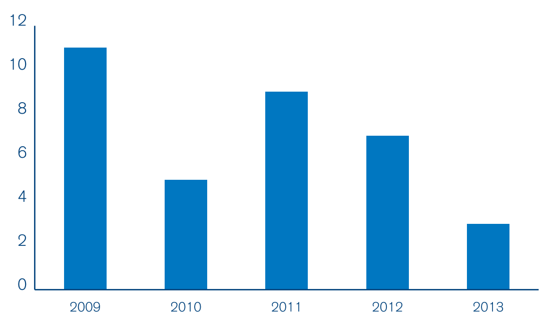


Accidents per Phase of Flight, 2009-2013

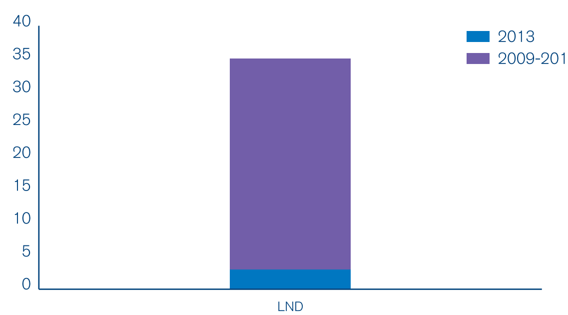


See Annex 1 for "Phase of Flight" definitions

Accidents per Year



Accidents per Phase of Flight



Top Contributing Factors, 2009-2013

See Annex 2 for "Contributing Factors" definitions

Latent Conditions (deficiencies in...)

- **31%** Flight operations:
  - Training systems (100% of these cases)
  - SOPs & checking (40% of these cases)
- **16%** Safety management

Threats

Environmental
- **47%** Meteorology:
  - Wind/wind shear/gusty wind (80% of these cases)
  - Poor visibility /IMC (20% of these cases)

Airline
None noted.

Flight Crew Errors (relating to...)

- **63%** Manual handling/flight controls
- **28%** Failure to go around after destabilized approach
- **22%** SOP adherence/SOP cross-verification:
  - Unintentional non-compliance (86% of these cases)
- **9%** Automation

Undesired Aircraft States

- **75%** Long/floated/bounced/firm/off-center/crabbed landing
- **22%** Unstable approach
- **19%** Vertical, lateral or speed deviations
- **13%** Abrupt aircraft control
- **13%** Continued landing after unstable approach

Countermeasures

- **25%** Monitor/cross-check
- **25%** Overall crew performance
- **16%** Contingency management
- **13%** Automation management

Additional Classifications

- **9%** Insufficient data for contributing factors

Relationships of Interest, 2009-2013

Manual handling of the aircraft was a factor in **71%** of hard landings where the crews landed long, floated, bounced, off-center or crabbed.

Deficiencies in flight operations training were noted in **56%** of hard landing accidents where the crew decision not to go around after destabilization also contributed to the accident.

Note: Three accidents were not classified due to insufficient data; these accidents were removed from the count for the contributing factors and relationships of interest.

Gear-up Landing/ Gear Collapse

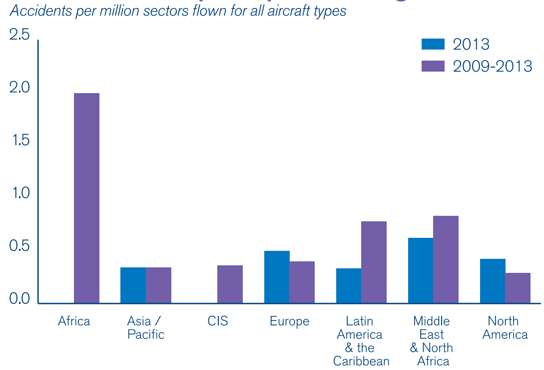
2013	13 Accidents
2009-2013	70 Accidents

	2013	'09-'13
IATA Members	**38%**	**23%**
Hull Losses	**8%**	**21%**
Fatal	**0%**	**0%**
Accident Rate	**0.36**	**0.41**

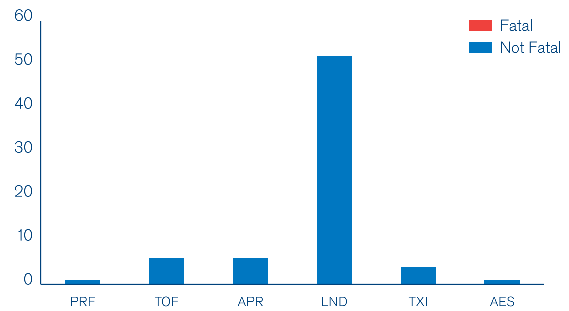
	Passenger	Cargo	Ferry	Jet	Turboprop
2013	**77%**	**23%**	**0%**	**38%**	**62%**
2009-2013	**80%**	**16%**	**4%**	**44%**	**56%**

Accident Rates per Operator Region

Accidents per million sectors flown for all aircraft types

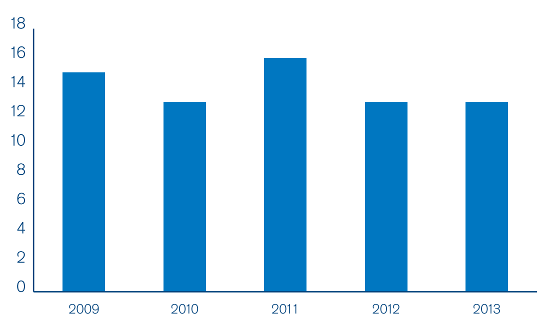


Accidents per Phase of Flight, 2009-2013

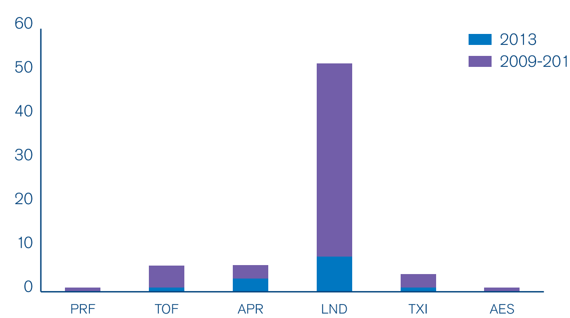


See Annex 1 for "Phase of Flight" definitions

Accidents per Year



Accidents per Phase of Flight



Top Contributing Factors, 2009-2013

See Annex 2 for "Contributing Factors" definitions

Latent Conditions (deficiencies in...)

23% Maintenance operations: SOPs & checking (100%* of these cases) Training systems (62%* of these cases)
16% Regulatory oversight
14% Design

Threats

Environmental
None noted.

Airline
75% Aircraft malfunction: Gear/tire (95%* of these cases) Hydraulic system failure (7%* of these cases)
30% Maintenance events

Flight Crew Errors (relating to...)

9% Manual handling/flight controls
9% SOP adherence/SOP cross-verification: Intentional non-compliance (40% of these cases) Unknown (40% of these cases)

Undesired Aircraft States

14% Landing gear

Countermeasures

7% Monitor/cross-check
4% Contingency management
4% Overall crew performance

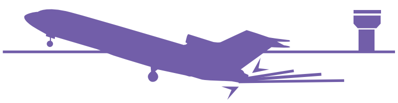
Additional Classifications

20% Insufficient data for contributing factors

Relationships of Interest, 2009-2013

Deficiencies in maintenance standard operating procedures and checking were noted as a factor in **92%** of accidents where incorrect configuration of the landing gear also contributed to the accident.

Note: 14 accidents were not classified due to insufficient data; these accidents were removed from the count for the contributing factors and relationships of interest.
** The sum of the percentages may exceed 100% due to multiple contributing factors.*



Tailstrike

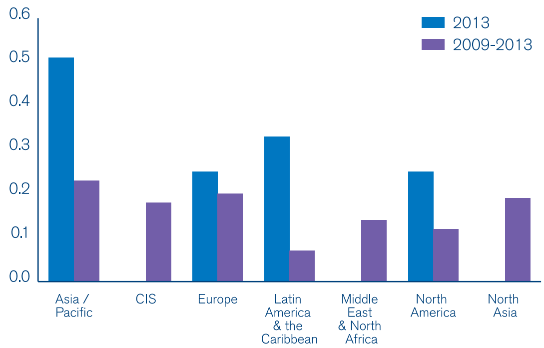
2013	9 Accidents
2009-2013	27 Accidents

	2013	'09-'13
IATA Members	67%	74%
Hull Losses	11%	4%
Fatal	0%	0%
Accident Rate	0.25	0.16

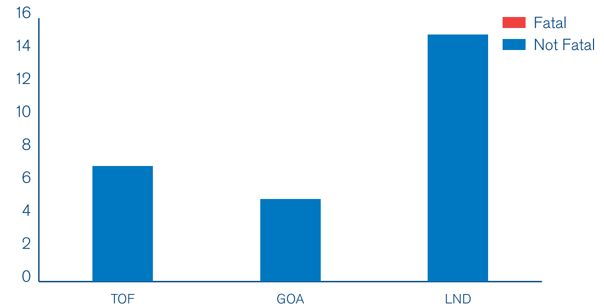
	Passenger	Cargo	Ferry	Jet	Turboprop
2013	89%	11%	0%	67%	33%
2009-2013	85%	15%	0%	85%	15%

Accident Rates per Operator Region

Accidents per million sectors flown for all aircraft types

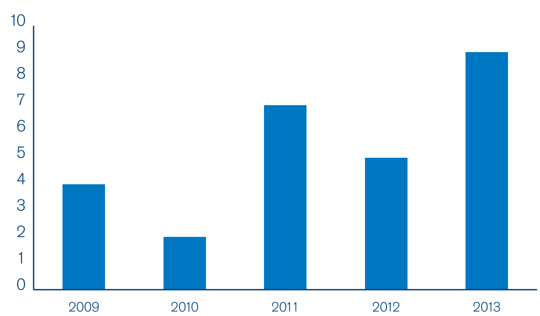


Accidents per Phase of Flight, 2009-2013

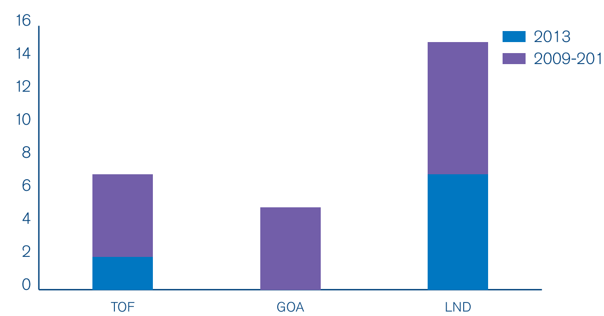


See Annex 1 for "Phase of Flight" definitions

Accidents per Year



Accidents per Phase of Flight



Top Contributing Factors, 2009-2013

See Annex 2 for "Contributing Factors" definitions

Latent Conditions (deficiencies in...)

35% Flight operations:
Training systems (88%* of these cases)
SOPs & checking (38%* of these cases)

13% Regulatory oversight

13% Technology & equipment

Threats

Environmental

22% Meteorology:
Wind/wind shear/gusty wind

Airline

None noted.

Flight Crew Errors (relating to...)

61% Manual handling/flight controls

39% SOP adherence/SOP cross-verification:
Unintentional non-compliance (56% of these cases)
Intentional non-compliance (33% of these cases)

17% Failure to go around after destabilized approach

13% Automation

Undesired Aircraft States

35% Long/floated/bounced/firm/off-center/crabbed land

26% Operation outside aircraft limitations

22% Weight & balance

13% Flight controls/automation

9% Continued landing after unstable approach

Countermeasures

30% Monitor/cross-check

17% Automation management

17% Leadership

13% Contingency management

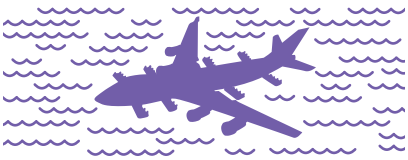
Additional Classifications

15% Insufficient data for contributing factors

Relationships of Interest, 2009-2013

In **71%** of accidents where there were noted deficiencies in flight crew training, improvements in flight crew monitoring or cross checking were noted as a potential prevention action for the accident.

Note: Four accidents were not classified due to insufficient data; these accidents were removed from the count for the contributing factors and relationships of interest.
** The sum of the percentages may exceed 100% due to multiple contributing factors.*



Off Airport Landing/ Ditching

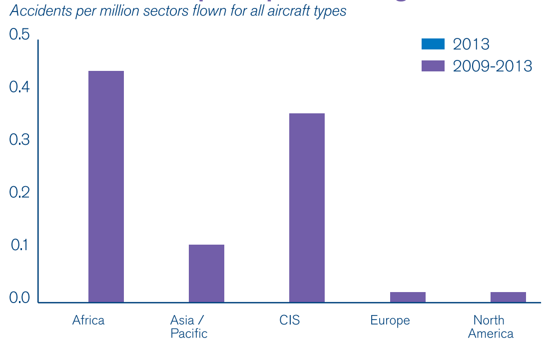
2013	0 Accidents
2009-2013	9 Accidents

	2013	'09-'13
IATA Members	N/A	11%
Hull Losses	N/A	89%
Fatal	N/A	44%
Accident Rate	0	0.05

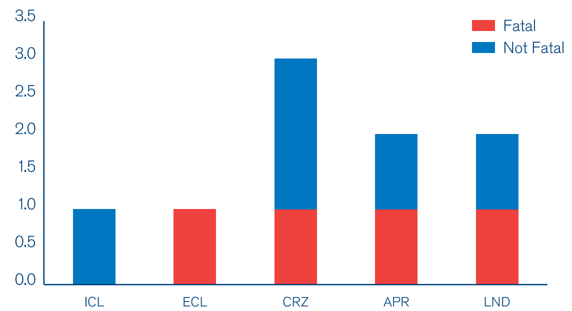
	Passenger	Cargo	Ferry	Jet	Turboprop
2013	N/A	N/A	N/A	N/A	N/A
2009-2013	56%	44%	0%	22%	78%

Accident Rates per Operator Region

Accidents per million sectors flown for all aircraft types

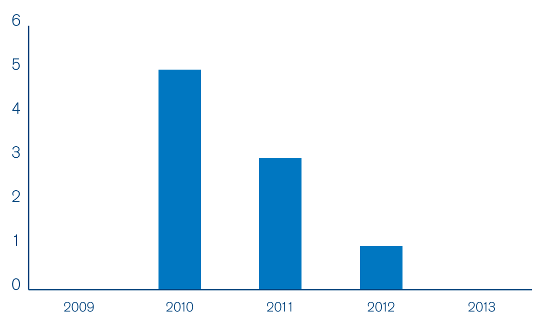


Accidents per Phase of Flight, 2009-2013

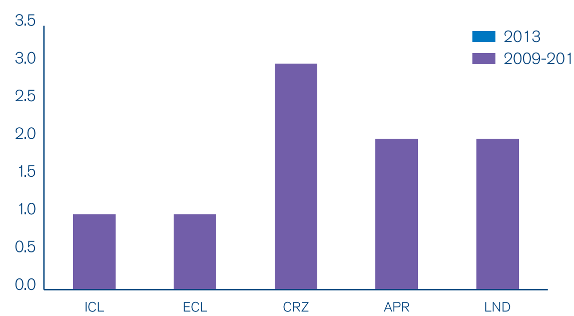


See Annex 1 for "Phase of Flight" definitions

Accidents per Year



Accidents per Phase of Flight



Top Contributing Factors, 2009-2013

See Annex 2 for "Contributing Factors" definitions

Latent Conditions (deficiencies in...)

38% Regulatory oversight

Threats

Environmental
None noted.

Airline
75% Aircraft malfunction:
Fire/ smoke (cockpit/ cabin/ cargo)
(50% of these cases)

Flight Crew Errors (relating to...)

None noted.

Undesired Aircraft States

None noted.

Countermeasures

None noted.

Additional Classifications

11% Insufficient data for contributing factors

Relationships of Interest, 2009-2013

None noted.

Note: One accident was not classified due to insufficient data; this accident was removed from the count for the contributing factors and relationships of interest.

TREND ANALYSIS

Accidents Overview (2009-2013)

	Total Accidents	IATA Members	Hull Losses	Fatal	Fatalities	Passenger	Cargo	Ferry	Jet	Turboprop
2013	81	28	32	16	210	63	15	3	38	43
2012	75	13	32	15	414	58	14	3	29	46
2011	92	34	39	22	490	79	10	3	55	37
2010	94	25	43	23	786	69	23	2	59	35
2009	90	28	35	18	685	66	22	2	59	31

Accidents per Category (2009-2013)

	Controlled Flight into Terrain	Loss of Control In-flight	Mid-air Collision	Runway/ Taxiway Excursion	In-flight Damage	Ground Damage	Undershoot	Hard Landing	Gear-up Landing/ Gear Collapse	Tailstrike	Off Airport Landing/ Ditching	Other End State
2013	6	8	-	17	7	12	2	3	13	9	-	2
2012	6	6	1	21	4	8	1	7	13	5	1	2
2011	10	8	-	17	5	15	1	9	16	7	3	-
2010	7	10	-	20	9	10	8	5	13	2	5	2
2009	2	9	-	23	9	9	4	11	15	4	-	1

Note 1: Two accidents in 2013 and nine in the last five years did not fit into any of the above categories and were not included in the table.
Note 2: The Off Airport Landing/Ditching category was added in 2010 and data from previous years is not included in the table.

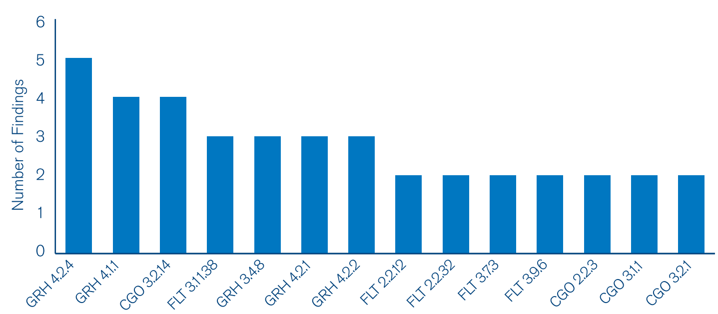
2013 Audit Results

To assist operators to better understand the latent conditions related to the top three high risk accident categories, IATA prepared a review of the IOSA Standards and Recommended Practices (ISARPs) related to Loss of Control In-flight, Controlled Flight into Terrain and Runway Excursions. These ISARPs were selected based on a review of the contributing factors to these categories as well as expert insight. This section presents the top findings and observations associated with the relevant ISARPs. For full details of the ISARPs, please refer to the IOSA Standards Manual.

Standards are requirements of the IOSA program and any non-conformities which result in findings must be closed to achieve registration. Recommended practices are guidance for operators and non-conformities which result in observations do not have to be closed to achieve registration.

LOSS OF CONTROL IN-FLIGHT

2013 Audit Results



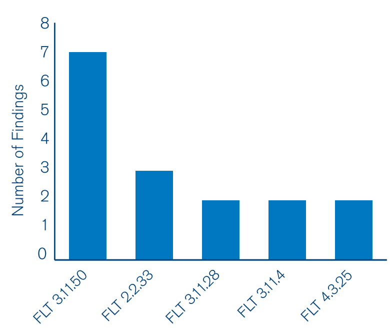
Details of Results

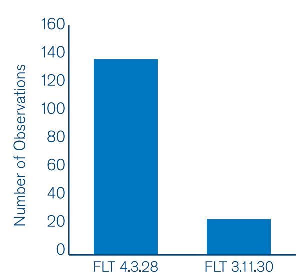
Deficiencies in the operator's policies or procedures for the storage and certification of de-icing / anti-icing fluid or fuel represented the most common findings in this category. Findings were also noted for the handling of aircraft cargo and dangerous goods.

For flight operations, the most common findings were in the operators' policies and procedures for flights in proximity to adverse weather.

CONTROLLED FLIGHT INTO TERRAIN

2013 Audit Results





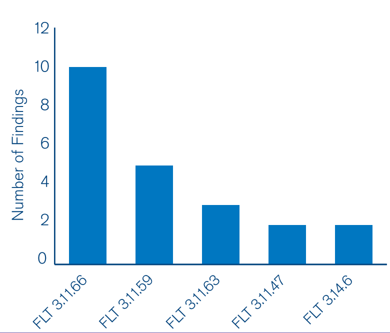
Details of Results

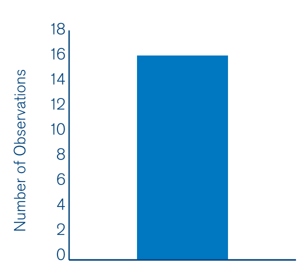
The primary findings in this category related to the operator's requirements to restrict descent rates at low heights above ground level and the need to ensure crews receive regular terrain closure training.

The two leading observations in this category related to the installation of forward-looking wind shear warning systems as well as the use of barometric pressure as the sole altitude reference for the take-off, approach and landing phases of flight.

RUNWAY EXCURSION

2013 Audit Results





Details of Results

The primary findings for Runway Excursions related to the operators' requirements to define and provide procedures to ensure stable descent profiles as well as the definition of stabilized approach criteria.

The most common observation in this category related to operators' guidance for crews to assess that sufficient landing distance is available on the runway of intended use.

Incident Data Analysis

FLIGHT DATA INCIDENTS

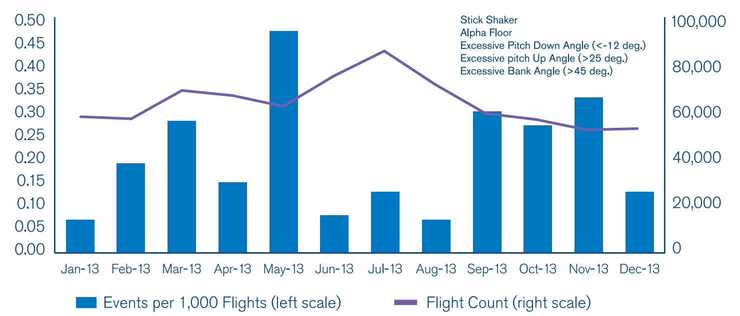
To better understand the threats faced by flight crews and the errors in the handling of those threats operators review incident data. This critical information from Air Safety Reports or from the analysis of flight data from aircraft provide insight into incidents so that mitigation strategies may be developed before incidents have the chance to lead to accidents. This section presents incident analysis related to the top three high risk accident categories.

Flight data incidents have been identified in IATA's Flight Data eXchange (FDX) program. FDX is an aggregated de-identified database of FDA/FOQA-type events that allows the user to identify commercial flight safety issues for a wide variety of safety topics, for many types of aircraft, across a global database; it also allows flight operations and safety departments to proactively identify safety hazards. The database contributors are primarily from Latin America with contributions from Africa and Asia Pacific as well.

The FDX database currently contains data from 30+ airlines and over 1,000,000 flights. The data is processed using a set of events based on industry input and feedback. The graphs below display trend information of events related to the three risk accident categories for the year 2013.

LOSS OF CONTROL INFLIGHT

Flight Data Incidents

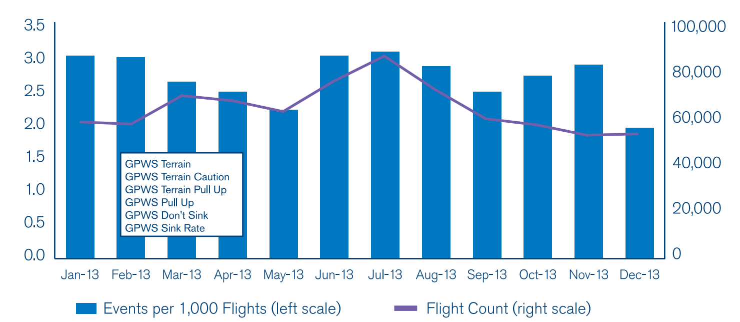


Description

This graph shows the number of loss of control precursor events per 1,000 flights detected in the FDX database along with the flight count per month. There is no clear trend in 2013 data. Loss of control precursor events are defined as abnormal aircraft attitude and stall protection system status.

CONTROLLED FLIGHT INTO TERRAIN

Flight Data Incidents



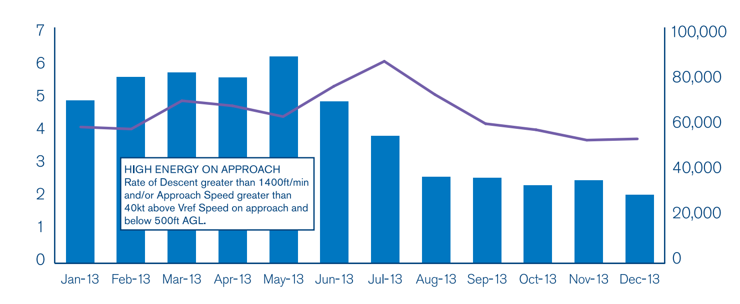
Description

This graph shows the number of GPWS events per 1,000 flights detected in the FDX database along with the flight count per month. It shows a slight decrease in 2013 and an average of 2.7 events per 1,000 flights.

The GPWS modes considered were: Terrain, Terrain Caution, Terrain Pull Up, Don't Sink and Sink Rate

RUNWAY EXCURSION

Flight Data Incidents



Description

It is understood that many factors can contribute to a runway excursion. This graph focuses on one of the factors, high-energy approach, and shows the number of high-energy-related events detected below 500ft above ground level (AGL) on approach per 1,000 approaches. There is a clear downward trend throughout the second half of 2013.

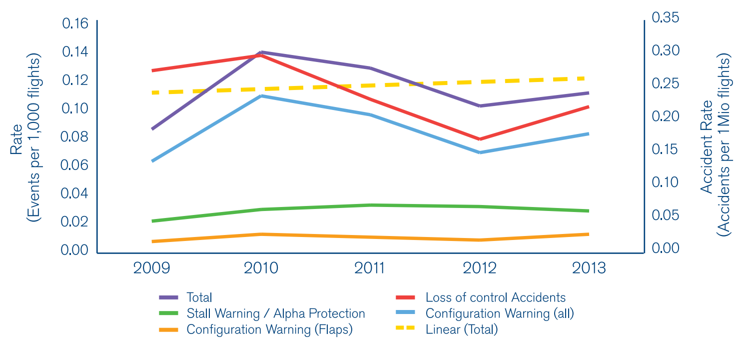
AIR SAFETY REPORT INCIDENTS

This analysis was conducted on Air Safety Reports (ASR) held in IATA's Safety Trend Evaluation, Analysis & Data Exchange System (STEADES) database. The STEADES database is comprised of Air Safety Reports collected from participating airlines and submitted to IATA quarterly. As at January 2014, there are 170 STEADES members. The rates are subject to fluctuations due to changes in STEADES membership and data submissions from member airlines. Users are reminded that data and rates presented are based on events reported by flight and cabin crew.

Initially focused on three accident categories, the STEADES precursors were introduced to identify potential precursors for accidents within the incident data. IATA's incident data was analyzed and the categories linked with the accident categories as identified by the Accident Classification Task Force (ACTF). The rates should give an overview about how potential precursors are reported over time and how the accident rate compares to the total precursor trend line. The study to identify accident precursors with incident data is still in development and under constant review and will be further enhanced in the future.

LOSS OF CONTROL IN-FLIGHT

Reported Incidents

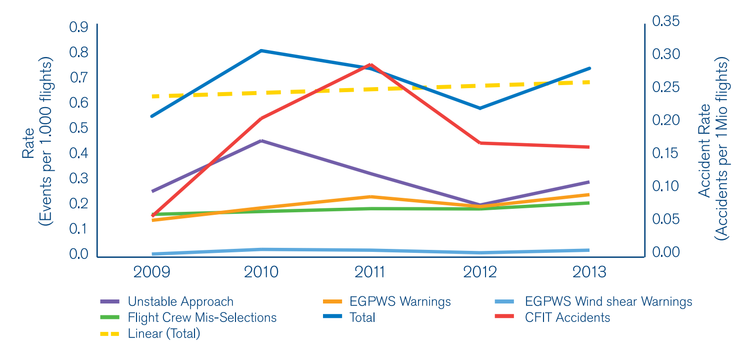


Description

The accident precursors for Loss of Control accidents include Configuration Warnings (all), Configuration Warnings (Flaps) and Stall Warning/Alpha Protection. The Precursor Total shows a slight increase over the last five years. No correlation has been identified between the precursors and the accident rate.

CONTROLLED FLIGHT INTO TERRAIN

Reported Incidents

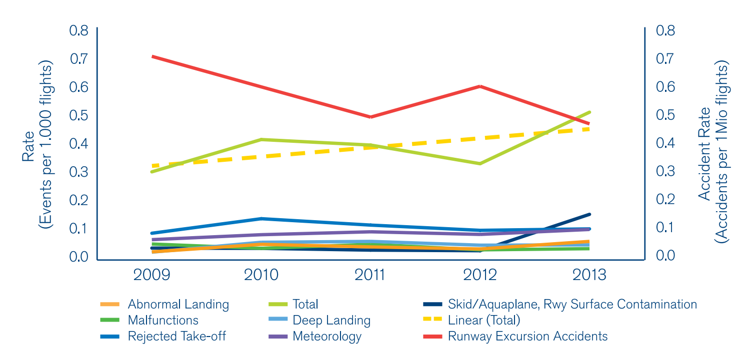


Description

The accident precursors for Controlled Flight into Terrain accidents include Unstable Approach, EGPWS Warnings, EGPWS Wind shear Warning as a separate category and Flight Crew Mis-selection. The Precursor Total shows an increase over the last five years. A positive Pearson correlation has been identified between the precursors and the accident rate.

RUNWAY EXCURSION

Reported Incidents



Description

The accident precursors for Runway Excursion accidents include Abnormal Landing, Deep Landing, Malfunctions, Meteorology, Rejected Take-off and Skid/Aquaplane/Runway Surface Contamination. The Precursor Total shows an increase over the last five years. A negative correlation has been identified between the precursors and the accident rate.

Section 5

In-Depth Regional Accident Analysis

Following the same model as the in-depth analysis by accident category presented in Section 4, this section presents an overview of occurrences and their contributing factors broken down by the region of the involved operators.

The purpose of this section is to identify issues that operators located in the same region may share, in order to develop adequate prevention strategies.

Note: IATA determines the accident region based on the operator's "home" country as specified in the operator's Air Operator Certificate (AOC).

For example, if a Canadian-registered operator has an accident in Europe, this accident is considered a North American accident.

*For a complete list of countries assigned per region, please consult **Annex 1**.*

Image courtesy of Bombardier

Africa

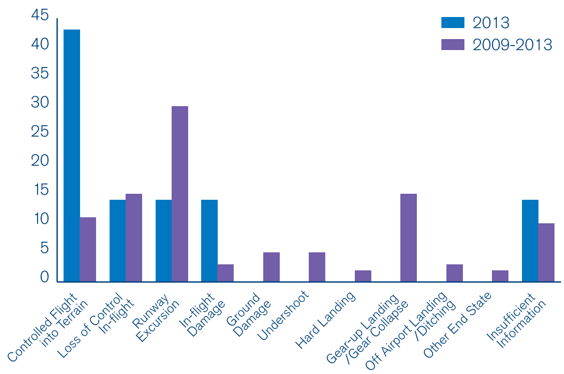
2013 — 7 Accidents
2009-2013 — 61 Accidents

	2013	'09-'13
IATA Members	14%	13%
Hull Losses	71%	67%
Fatal	71%	36%
Accident Rate	7.45	13.47

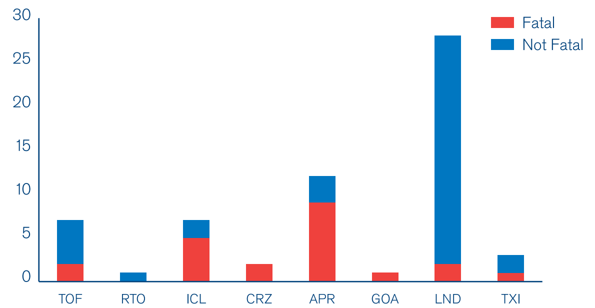
	Passenger	Cargo	Ferry	Jet	Turboprop
2013	57%	14%	29%	14%	86%
2009-2013	56%	34%	10%	36%	64%

Breakdown by Category

Distribution of accidents by percentage of region total

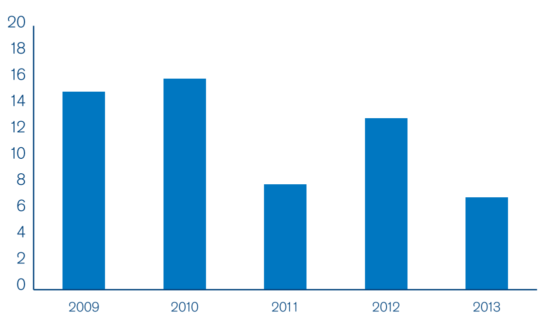


Accidents per Phase of Flight, 2009-2013

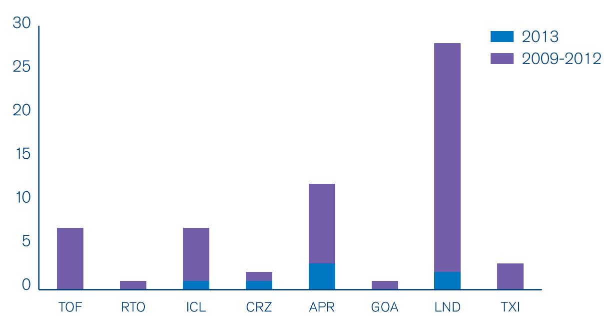


See Annex 1 for "Phase of Flight" definitions

Accidents per Year



Accidents per Phase of Flight



Top Contributing Factors, 2009-2013

See Annex 2 for "Contributing Factors" definitions

Latent Conditions (deficiencies in…)

49% Regulatory oversight
32% Safety management
17% Flight operations: Training systems
17% Management decisions

Threats

Environmental
28% Airport Facilities
17% Thunderstorms

Airline
32% Aircraft malfunction: Gear/tire (47% of these cases) Contained engine failure (27% of these cases)

Flight Crew Errors (relating to…)

23% Manual handling of flight controls
23% SOP adherence/SOP cross-verification: Intentional non-compliance (64% of these cases) Unintentional non-compliance (36% of these cases)

Undesired Aircraft States

15% Long/floated/bounced/firm/off-center/crabbed landing
15% Vertical/lateral/speed deviation
11% Engine

Countermeasures

23% Overall crew performance
15% Monitor/cross-check

Additional Classifications

13% Insufficient data for contributing factors

Relationships of Interest, 2009-2013

61% of accidents that noted regulatory oversight as a contributing factor also indicated safety management as a factor.

45% of all manual handling/flight control-related accidents noted threats from meteorological conditions.

Note: Eight accidents were not classified due to insufficient data; these accidents were removed from the count for the contributing factors and relationships of interest.

Asia/Pacific

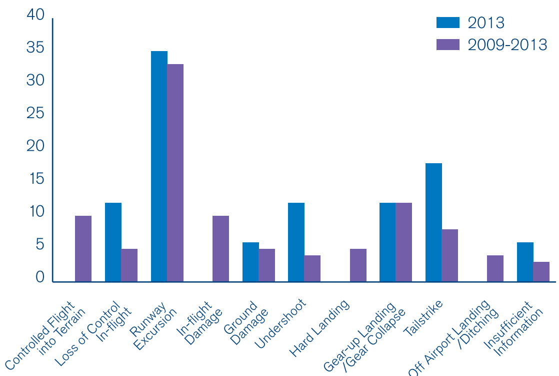
2013	17 Accidents
2009-2013	73 Accidents

	2013	'09-'13
IATA Members	29%	33%
Hull Losses	41%	38%
Fatal	12%	23%
Accident Rate	2.89	2.78

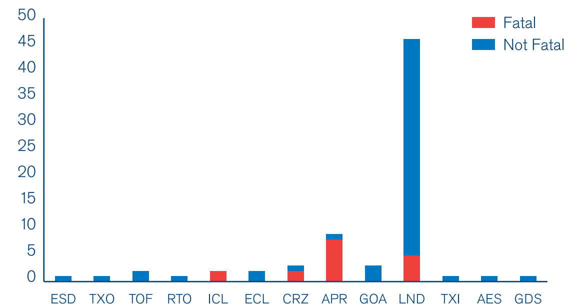
	Passenger	Cargo	Ferry	Jet	Turboprop
2013	88%	12%	0%	41%	59%
2009-2013	86%	14%	0%	52%	48%

Breakdown by Category

Distribution of accidents by percentage of region total

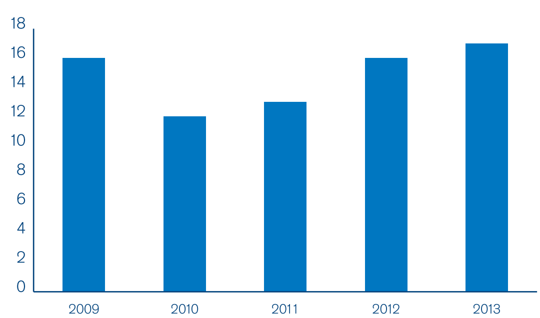


Accidents per Phase of Flight, 2009-2013

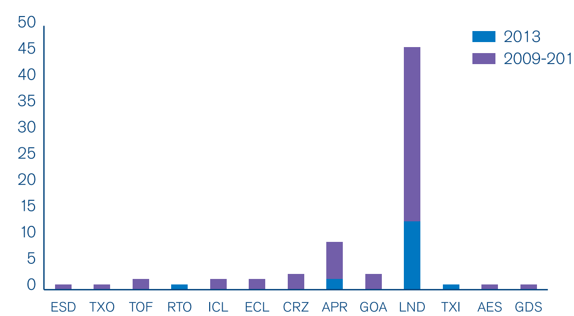


See Annex 1 for "Phase of Flight" definitions

Accidents per Year



Accidents per Phase of Flight



Top Contributing Factors, 2009-2013

Latent Conditions
(deficiencies in...)

- **50%** Regulatory oversight
- **41%** Safety management
- **19%** Flight operations: training systems

Threats

Environmental

- **34%** Meteorology:
  - Wind/wind shear/gusty wind (59% of cases)
  - Poor visibility/IMC (36% of cases)
- **20%** Ground-based navigation aids malfunctioning or not available
- **11%** Contaminated runway/ taxiway – poor breaking action

Threats
(cont'd)

Airline

- **31%** Aircraft malfunction:
  - Gear/tire (35% of cases)
  - Fire/smoke (cockpit/cabin/ cargo) (20% of cases)
- **11%** Maintenance events

Flight Crew Errors
(relating to...)

- **38%** Manual handling/flight controls
- **27%** SOP adherence/SOP cross-verification:
  - Intentional non-compliance (82% of these cases)
  - Unintentional non-compliance (12% of these cases)
- **9%** Failure to go around after destabilization on approach

Undesired Aircraft States

- **27%** Long/floated/bounced/ firm/off-center/crabbed landing
- **23%** Vertical/lateral/speed deviation
- **14%** Unstable approach
- **13%** Continued landing after unstable approach

Countermeasures

- **39%** Overall crew performance
- **31%** Monitor/cross-check
- **14%** Contingency management

Additional Classifications

- **13%** Insufficient data for contributing factors

Relationships of Interest, 2009-2013

72% of accidents that indicated weak regulatory oversight as a latent condition also indicated deficiencies in the operator's safety management.

Half of the accidents that indicated errors related to flight crew manual handling resulted in a long, floated, bounced, firm, or off-center landing.

Note: Seven accidents were not classified due to insufficient data; these accidents were removed from the count for the contributing factors and relationships of interest.

Commonwealth of Independent States (CIS)

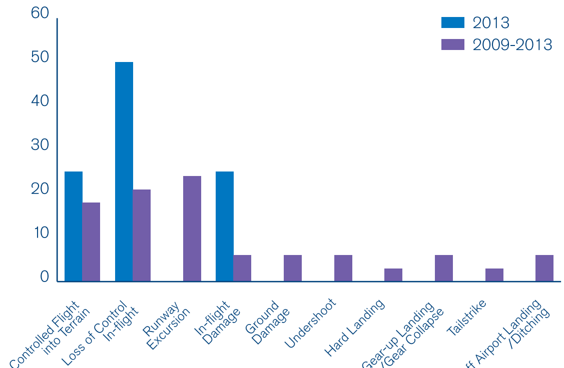
2013 — 4 Accidents
2009-2013 — 33 Accidents

	2013	'09-'13
IATA Members	0%	12%
Hull Losses	75%	70%
Fatal	75%	52%
Accident Rate	3.17	5.97

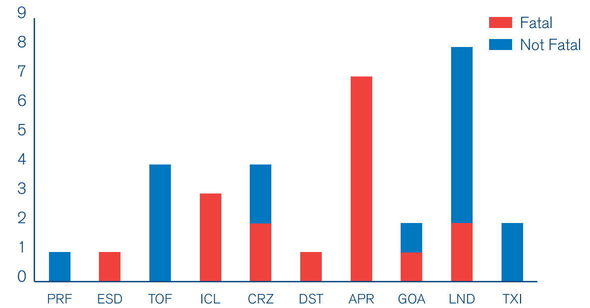
	Passenger	Cargo	Ferry	Jet	Turboprop
2013	100%	0%	0%	75%	25%
2009-2013	79%	15%	6%	67%	33%

Breakdown by Category

Distribution of accidents by percentage of region total

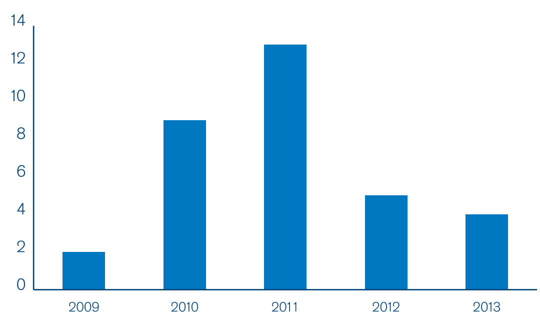


Accidents per Phase of Flight, 2009-2013

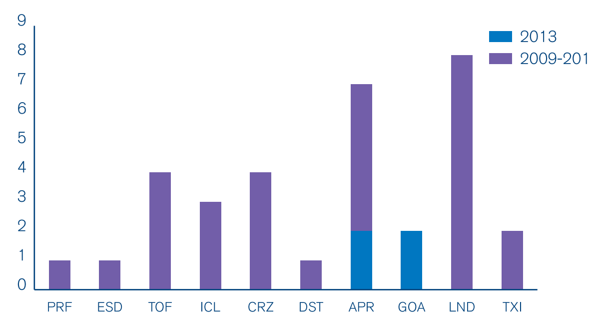


See Annex 1 for "Phase of Flight" definitions

Accidents per Year



Accidents per Phase of Flight



Top Contributing Factors, 2009-2013

See Annex 2 for "Contributing Factors" definitions

Latent Conditions (deficiencies in...)

52% Regulatory oversight
41% Safety management
21% Flight operations: training systems
14% Technology and equipment

Threats

Environmental
48% Meteorology:
Poor visibility/IMC (57% of these cases)
Wind/wind shear/gusty wind (29% of these cases)
Icing conditions (14% of these cases)
10% Air traffic services

Airline
28% Aircraft malfunction:
Contained engine failure/powerplant malfunction (38% of cases)
Fire/smoke (cockpit/cabin/cargo) (38% of cases)
14% Maintenance events

Flight Crew Errors (relating to...)

52% SOP adherence/SOP cross-verification:
Intentional non-compliance (87%* of these cases)
Unintentional non-compliance (20%* of these cases)
34% Manual handling/flight controls
17% Callouts

Undesired Aircraft States

41% Vertical/lateral/speed deviation
17% Unnecessary weather penetration
17% Unstable approach

Countermeasures

31% Overall crew performance
21% Monitor/cross-check
17% Contingency management

Additional Classifications

12% Insufficient data for contributing factors

Relationships of Interest, 2009-2013

73% of all accidents that noted deficiencies in regulatory oversight as a latent condition also noted flight crew errors related to SOP adherence or SOP cross-verification.

83% of accidents where deviations from flight path or speeds were a factor also noted intentional violations of SOPs.

Note: Four accidents were not classified due to insufficient data; these accidents were removed from the count for the contributing factors and relationships of interest.
** The sum of the percentages may exceed 100% due to multiple contributing factors.*

Europe

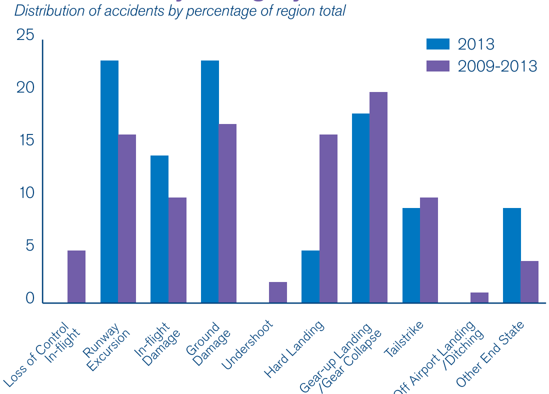
2013	22 Accidents
2009-2013	82 Accidents

	2013	'09-'13
IATA Members	50%	41%
Hull Losses	27%	23%
Fatal	0%	4%
Accident Rate	2.76	2.03

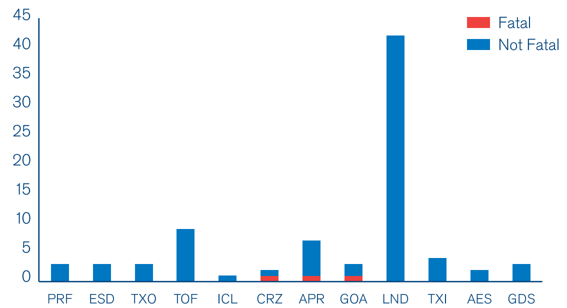
	Passenger	Cargo	Ferry	Jet	Turboprop
2013	77%	18%	5%	55%	45%
2009-2013	83%	15%	2%	60%	40%

Breakdown by Category

Distribution of accidents by percentage of region total

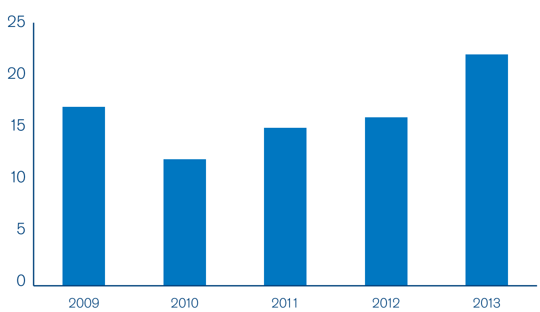


Accidents per Phase of Flight, 2009-2013

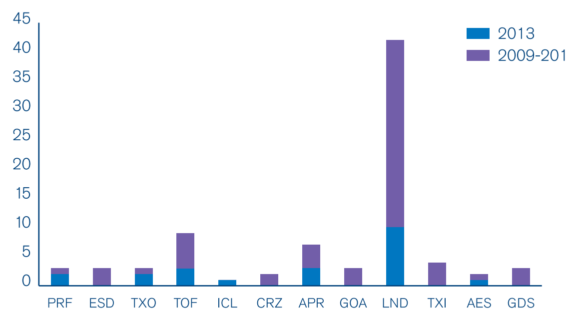


See Annex 1 for "Phase of Flight" definitions

Accidents per Year



Accidents per Phase of Flight



Top Contributing Factors, 2009-2013

See Annex 2 for "Contributing Factors" definitions

Latent Conditions (deficiencies in…)

- **14%** Flight operations: training systems
- **10%** Regulatory oversight
- **10%** Design
- **9%** Safety management

Threats

Environmental

- **29%** Meteorology:
  - Wind/wind shear/gusty wind (70% of these cases)
  - Poor visibility/IMC (17% of these cases)
- **13%** Air traffic services

Airline

- **23%** Aircraft malfunction:
  - Gear/tire (61% of cases)
  - Contained engine failure/ powerplant malfunction (17% of cases)
- **9%** Ground events

Flight Crew Errors (relating to…)

- **27%** Manual handling/flight controls
- **24%** SOP adherence/SOP cross-verification:
  - Unintentional non-compliance (47% of these cases)
  - Intentional non-compliance (37% of these cases)
- **13%** Failure to go around after destabilization on approach

Undesired Aircraft States

- **23%** Long/floated/bounced/ firm/off-centerline landing
- **13%** Operation outside of aircraft limitations

Countermeasures

- **18%** Overall crew performance
- **15%** Monitor/cross-check
- **14%** Contingency management

Additional Classifications

- **5%** Insufficient data for contributing factors

Relationships of Interest, 2009-2013

More than **half** of the accidents that are related to errors in aircraft manual handling also indicated meteorological conditions as a threat.

55% of accidents with noted deficiencies in an operator's flight operations training systems resulted in a long, floated, bounced, firm, off-center, or crabbed landing

Note: Four accidents were not classified due to insufficient data; these accidents were removed from the count for the contributing factors and relationships of interest.

Latin America & the Caribbean

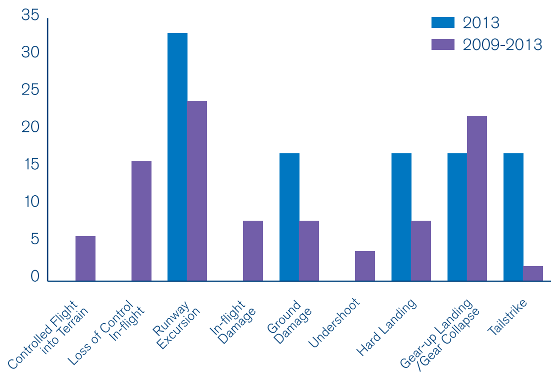
2013 6 Accidents
2009-2013 49 Accidents

	2013	'09-'13
IATA Members	50%	14%
Hull Losses	67%	57%
Fatal	17%	27%
Accident Rate	1.99	3.46

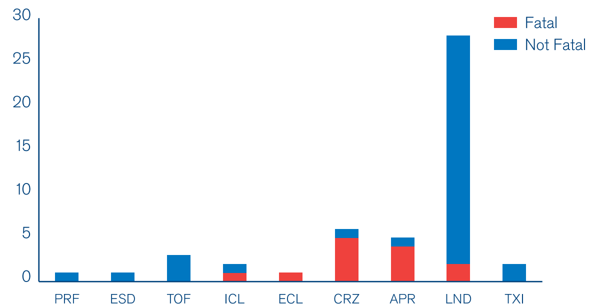
	Passenger	Cargo	Ferry	Jet	Turboprop
2013	100%	0%	0%	33%	67%
2009-2013	90%	10%	0%	43%	57%

Breakdown by Category

Distribution of accidents by percentage of region total

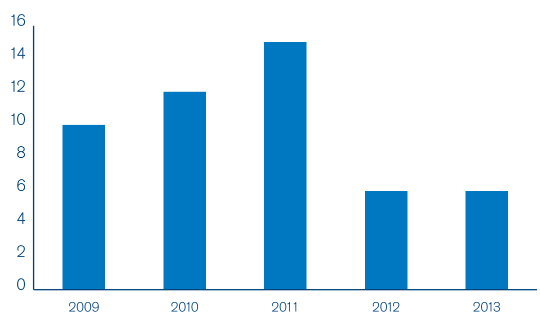


Accidents per Phase of Flight, 2009-2013

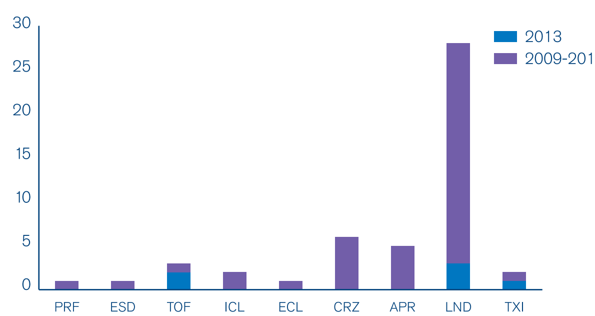


See Annex 1 for "Phase of Flight" definitions

Accidents per Year



Accidents per Phase of Flight



Top Contributing Factors, 2009-2013

See Annex 2 for "Contributing Factors" definitions

Latent Conditions
(deficiencies in...)

20% Safety management
18% Regulatory oversight
14% Flight operations: training systems
9% Maintenance operations: SOPs and checking

Threats

Environmental
20% Ground-based nav aid malfunction or not available
20% Meteorology:
Wind/wind shear/gusty wind (33% of these cases)
Thunderstorms (33% of these cases)

Airline
36% Aircraft malfunction:
Gear/tire (50% of cases)
Brakes (19% of cases)
11% Maintenance events

Flight Crew Errors
(relating to...)

23% Manual handling/flight controls
18% SOP adherence/SOP cross-verification:
Intentional non-compliance (50% of these cases)
Unintentional non-compliance (38% of these cases)

Undesired Aircraft States

16% Vertical/lateral/speed deviation
14% Long/floated/bounced/firm/off-centerline landing
11% Unstable approach

Countermeasures

20% Monitor/cross-check
20% Overall crew performance

Additional Classifications

10% Insufficient data for contributing factors

Relationships of Interest, 2009-2013

44% of accidents related to ground-based navigation aid malfunctions or a lack of navigation aids as threat also indicated errors related to manual handling/flight control.

Note: Five accidents were not classified due to insufficient data; these accidents were removed from the count for the contributing factors and relationships of interest.

Middle East & North Africa

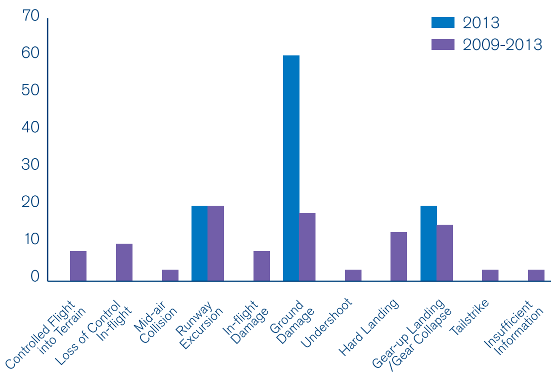
2013 — 5 Accidents
2009-2013 — 40 Accidents

	2013	'09-'13
IATA Members	40%	65%
Hull Losses	20%	45%
Fatal	0%	23%
Accident Rate	3.12	5.55

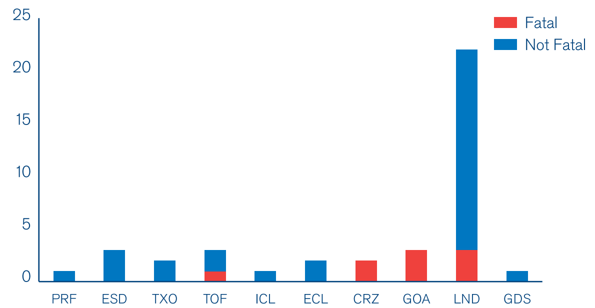
	Passenger	Cargo	Ferry	Jet	Turboprop
2013	100%	0%	0%	80%	20%
2009-2013	87.5%	7.5%	5%	82.5%	17.5%

Breakdown by Category

Distribution of accidents by percentage of region total

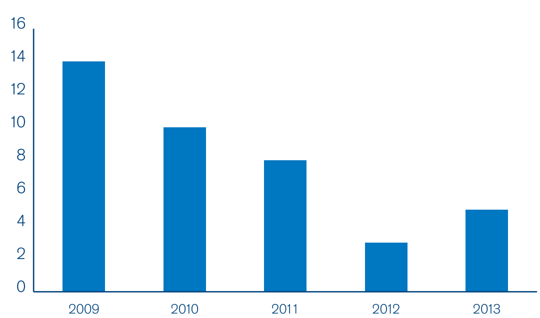


Accidents per Phase of Flight, 2009-2013

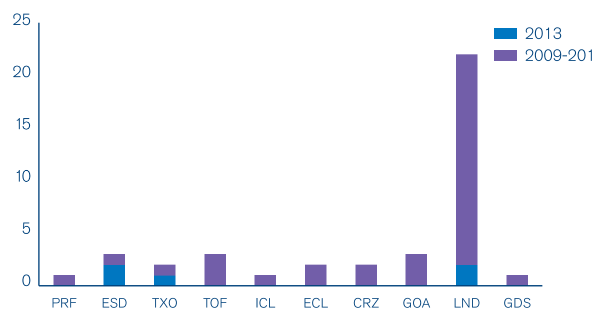


See Annex 1 for "Phase of Flight" definitions

Accidents per Year



Accidents per Phase of Flight



Top Contributing Factors, 2009-2013

See Annex 2 for "Contributing Factors" definitions

Latent Conditions (deficiencies in...)

- **20%** Regulatory oversight
- **20%** Safety management
- **9%** Design
- **9%** Flight operations: training systems
- **9%** Flight operations: SOPs and checking

Threats

Environmental

- **29%** Meteorology:
  - Poor visibility/IMC (40% of these cases)
  - Wind/wind shear/gusty wind (30% of these cases)
- **9%** Air traffic services
- **9%** Ground-based nav aid malfunction/not available

Airline

- **29%** Aircraft malfunction:
  - Gear/tire (40% of cases)
  - Contained engine failure/ powerplant malfunction (30% of cases)
- **14%** Maintenance events

Flight Crew Errors (relating to...)

- **31%** Manual handling/flight controls
- **29%** SOP adherence/SOP cross-verification:
  - Intentional non-compliance (50% of these cases)
  - Unintentional non-compliance (50% of these cases)
- **9%** Automation

Undesired Aircraft States

- **20%** Long/floated/bounced/ firm/off-centerline landing
- **14%** Unstable approach
- **14%** Vertical/lateral/speed deviation

Countermeasures

- **23%** Overall crew performance
- **20%** Monitor/cross-check
- **9%** Automation Management

Additional Classifications

- **10%** Insufficient data for contributing factors

Relationships of Interest, 2009-2013

55% of accidents indicating errors related to manual handling/flight controls resulted in a long/floated/bounced/firm/off-center/crabbed landing.

Half of the accidents related to meteorology as an environmental threat were related to manual handling/flight control errors.

Note: Four accidents were not classified due to insufficient data; these accidents were removed from the count for the contributing factors and relationships of interest.

North America

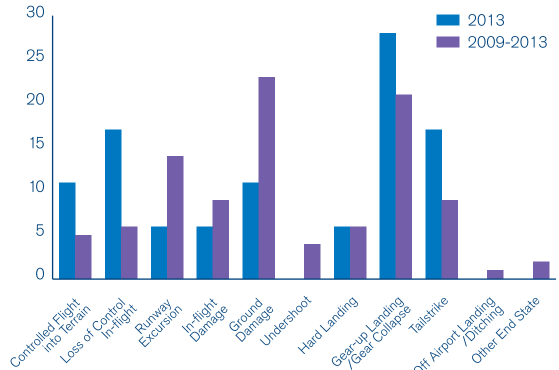
2013	18 Accidents
2009-2013	81 Accidents

	2013	'09-'13
IATA Members	22%	21%
Hull Losses	33%	27%
Fatal	28%	15%
Accident Rate	1.52	1.38

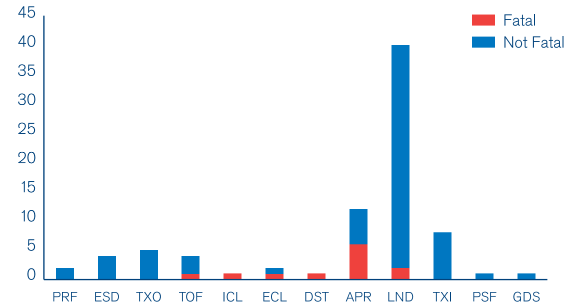
	Passenger	Cargo	Ferry	Jet	Turboprop
2013	61%	39%	0%	39%	61%
2009-2013	70%	29%	1%	53%	47%

Breakdown by Category

Distribution of accidents by percentage of region total

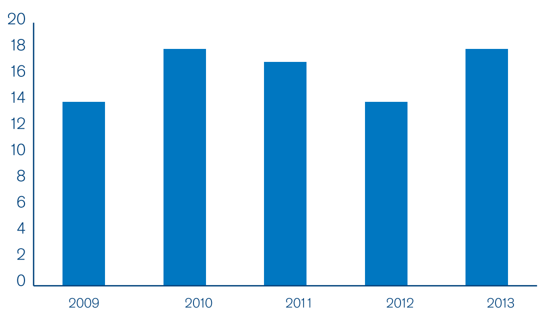


Accidents per Phase of Flight, 2009-2013

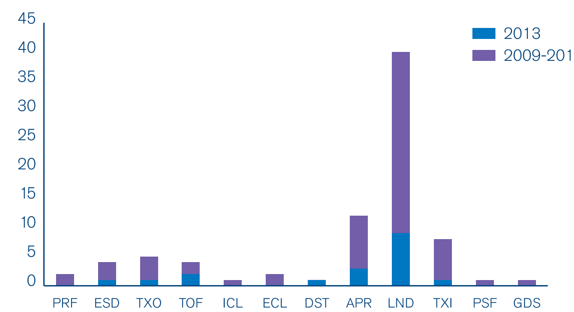


See Annex 1 for "Phase of Flight" definitions

Accidents per Year



Accidents per Phase of Flight



Top Contributing Factors, 2009-2013

See Annex 2 for "Contributing Factors" definitions

Latent Conditions (deficiencies in...)

- **16%** Regulatory oversight
- **10%** Flight operations: training systems
- **7%** Technology and equipment
- **6%** Design

Threats

Environmental

- **22%** Meteorology:
  - Wind/wind shear/gusty wind (60% of these cases)
  - Poor visibility/IMC (40% of these cases)
- **7%** Air traffic services
- **7%** Ground-based nav aid malfunction/not available

Airline

- **29%** Aircraft malfunction:
  - Gear/tire (50% of cases)
  - Fire/smoke (cockpit/cabin/cargo) (20% of cases)
- **10%** Maintenance events

Flight Crew Errors (relating to...)

- **17%** Manual handling/flight controls
- **13%** SOP adherence/SOP cross-verification:
  - Intentional non-compliance (33% of these cases)
  - Unintentional non-compliance (33% of these cases)
  - Unknown (33% of these cases)

Undesired Aircraft States

- **14%** Long/floated/bounced/firm/off-centerline landing
- **10%** Vertical/lateral/speed deviation
- **6%** Controlled flight toward terrain
- **6%** Ramp movements

Countermeasures

- **13%** Monitor/cross-check
- **9%** Overall crew performance
- **7%** Contingency Management

Additional Classifications

- **15%** Insufficient data for contributing factors

Relationships of Interest, 2009-2013

67% of accidents that involved errors related to SOP adherence/SOP corss-verification were related to meteorology as an environmental threat.

75% of accidents that resulted in controlled flight towards terrain as an undesired aircraft state mentioned deficiencies in regulatory oversight.

Note: 12 accidents were not classified due to insufficient data; these accidents were removed from the count for the contributing factors and relationships of interest.

North Asia

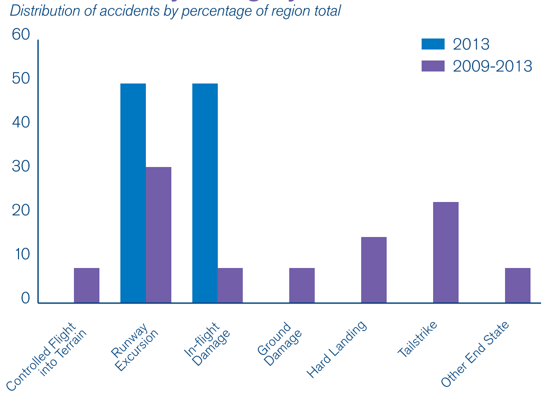
2013 2 Accidents
2009-2013 13 Accidents

	2013	'09-'13
IATA Members	100%	62%
Hull Losses	0%	15%
Fatal	0%	8%
Accident Rate	0.53	0.83

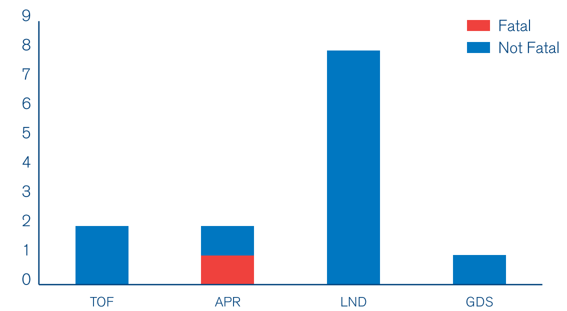
	Passenger	Cargo	Ferry	Jet	Turboprop
2013	50%	50%	0%	100%	0%
2009-2013	62%	38%	0%	92%	8%

Breakdown by Category

Distribution of accidents by percentage of region total

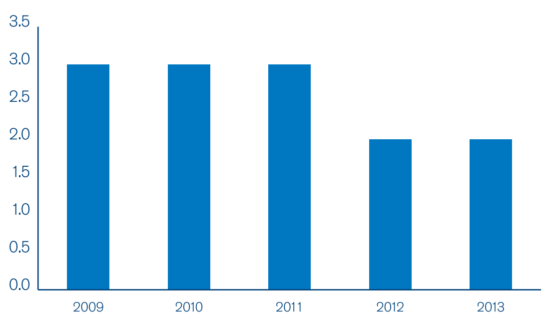


Accidents per Phase of Flight, 2009-2013

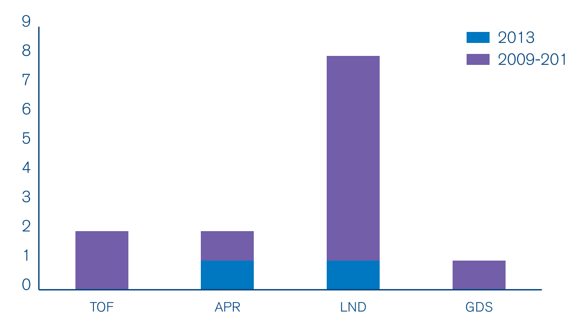


See Annex 1 for "Phase of Flight" definitions

Accidents per Year



Accidents per Phase of Flight



Top Contributing Factors, 2009-2013

See Annex 2 for "Contributing Factors" definitions

Latent Conditions (deficiencies in...)

27% Flight operations: training systems
27% Regulatory oversight

Threats

Environmental
27% Meteorology:
Wind/wind shear/gusty wind (67% of these cases)
Poor visibility/IMC (33% of these cases)

Airline
27% Aircraft malfunction:
Contained engine failure/powerplant malfunction (67% of cases)
Secondary flight controls (33% of cases)
9% Maintenance events

Flight Crew Errors (relating to...)

45% Manual handling/flight controls

Undesired Aircraft States

45% Long/floated/bounced/firm/off-centerline landing

Countermeasures

27% Monitor/cross-check

Additional Classifications

15% Insufficient data for contributing factors

Relationships of Interest, 2009-2013

67% of accidents related to deficiencies in regulatory oversight also mentioned aircraft malfunction as an airline threat.

67% of accidents that mentioned meteorology as an environmental threats indicated that errors related to manual handling/flight controls were a factor.

Note: Two accidents were not classified due to insufficient data; these accidents were removed from the count for the contributing factors and relationships of interest.

REGIONAL TREND ANALYSIS

Accident Overview (2009-2013)

	Africa	Asia/Pacific	Commonwealth of Independent States (CIS)	Europe	Latin America & the Caribbean	Middle East & North Africa	North America	North Asia
2013	7	17	4	22	6	5	18	2
2012	13	16	5	16	6	3	14	2
2011	8	13	13	15	15	8	17	3
2010	18	12	9	12	12	10	18	3
2009	15	15	2	17	10	14	14	3


Image courtesy of Airbus

Section 6

Analysis of Cargo Aircraft Accidents

2013 CARGO OPERATOR REVIEW

Cargo vs. Passenger Operations for Western-built Jet Aircraft

	Fleet Size End of 2013	HL	HL per 1000 Aircraft	SD	Total	Operational Accidents per 1000 Aircraft
Cargo	2,069	3	1.45	2	5	2.42
Passenger	20,621	9	0.44	24	33	1.60
Total	22,690	12	0.53	26	38	1.67

HL = Hull Loss   SD = Substantial Damage

Note: Fleet Size includes both in-service and stored aircraft operated by commercial airlines.
Cargo aircraft are defined as dedicated cargo, mixed passenger/cargo (combi) or quick-change configurations.

Cargo vs. Passenger Operations for Western-built Turboprop Aircraft

	Fleet Size End of 2013	HL	HL per 1000 Aircraft	SD	Total	Operational Accidents per 1000 Aircraft
Cargo	1,294	6	4.64	4	10	7.73
Passenger	3,892	11	2.83	19	30	7.71
Total	5,186	17	3.28	23	40	7.71

HL = Hull Loss   SD = Substantial Damage

Note: Fleet Size includes both in-service and stored aircraft operated by commercial airlines.
Cargo aircraft are defined as dedicated cargo, mixed passenger/cargo (combi) or quick-change configurations.

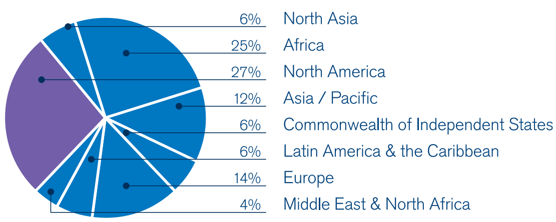
2009-2013 Cargo Aircraft Accidents

84 Accidents

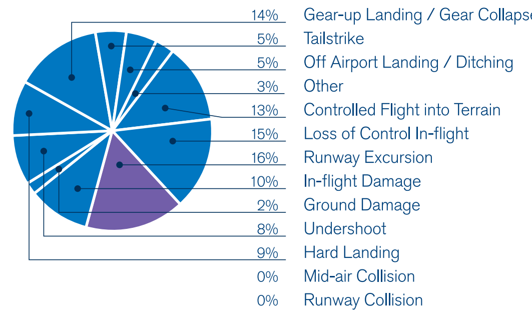
IATA Members	**20%**
Hull Losses	**60%**
Fatal	**35%**

46% Jet | **54%** Turboprop

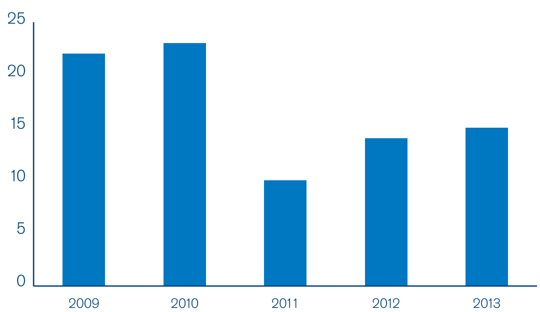
Breakdown per Operator Region



Breakdown per Accident Category

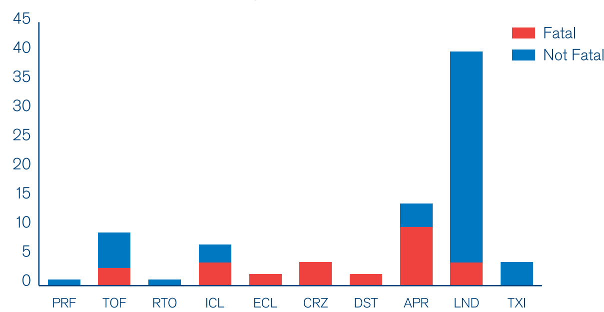


Accidents per Year



Accidents per Phase of Flight

See Annex 1 for detailed "Phase of Flight" definitions



Top Contributing Factors, 2009-2013

See Annex 2 for "Contributing Factors" definitions

Latent Conditions (deficiencies in...)

37% Regulatory oversight
28% Safety management
15% Management decisions
13% Maintenance operations: SOPs & checking

Threats

Environmental
23% Meteorology:
Poor visibility/IMC (57% of these cases)
Wind/wind shear/gusty wind (43% of these cases)
12% Ground-based nav aid malfunction or unavailable

Airline
42% Aircraft malfunction:
Contained engine failure/powerplant malfunction (28% of these cases)
Gear/tire (24% of these cases)
12% Maintenance events

Flight Crew Errors (relating to...)

15% SOP adherence/SOP cross verification
13% Manual handling/flight controls

Undesired Aircraft States

15% Vertical/lateral/speed deviation
12% Long/floated/bounced/firm/off-center/crabbed landing

Countermeasures

13% Monitor/Cross Check
12% Contingency Management
12% Overall Crew Performance

Additional Classifications

23% Insufficient data for contributing factors

Relationships of Interest, 2009-2013

None observed.

Note: 19 accidents were not classified due to insufficient data; these accidents were removed from the count for the contributing factors and relationships of interest.

Section 7

Cabin Safety

This section highlights accidents that had a cabin safety element. It is important to note that only those events that were the result of an accident, according to the IATA definition in Annex 1, are included in this analysis.

The following definitions apply to the events in this section:

Evacuation: Passengers and/or crew evacuate aircraft via escape slides, doors, emergency exits, or gaps in fuselage, usually initiated in life threatening or catastrophic events.

Rapid Deplaning: Passengers and/or crew rapidly exit aircraft via boarding doors and jet bridges or stairs, for precautionary measures.

SUMMARY OF FINDINGS

- Out of the 81 total accidents in 2013, 37 contained a cabin safety dimension
  - 62% of these accidents occurred on turboprop aircraft
  - 57% of these accidents occurred during the landing phase
  - 49% of these accidents resulted in a hull loss
  - 38% of these accidents occurred on jet aircraft
  - 30% of these accidents involved IATA members
  - 16% of these accidents resulted in fatalities

In terms of cabin-related events, the breakdown is as follows:

- The predominant cabin-related event was evacuation, which accounted for 95% of all cabin-related events
- 2 accidents involved a ditching

2013 Cabin Safety Related Accidents

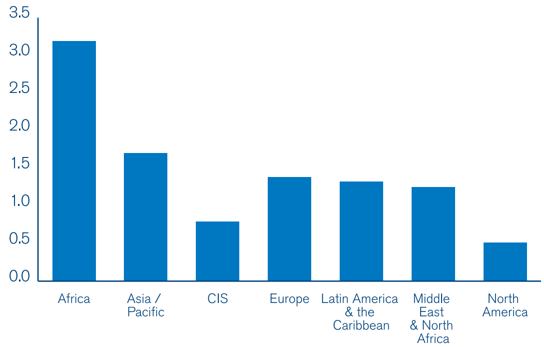
37 Accidents

IATA Members	**30%**
Hull Losses	**49%**
Fatal	**16%**
Accident Rate*	**1.02**

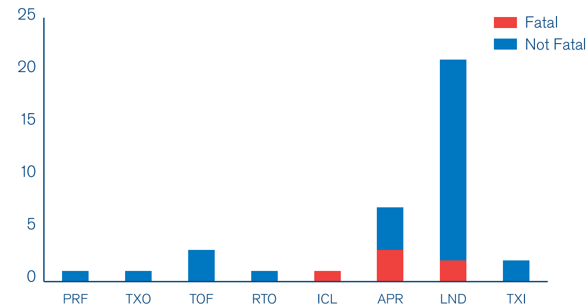
38% Jet | **62%** Turboprop

Accident Rates per Operator Region

Accidents per million sectors flown for all aircraft types

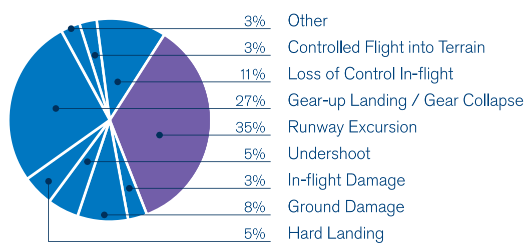


Accidents per Phase of Flight

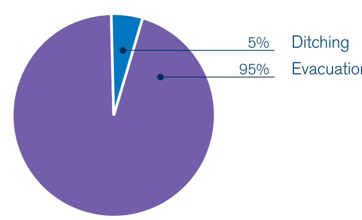


See Annex 1 for "Phase of Flight" definitions

Breakdown per Accident Category

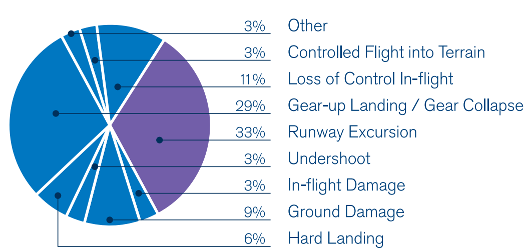


Breakdown per Additional Categories

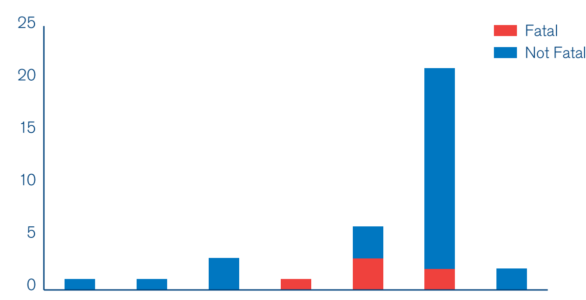


Focus on Evacuations

Breakdown per Accident Category



Accidents per Phase of Flight



See Annex 1 for "Phase of Flight" definitions

**Accidents with cabin safety related end state per million sectors.*

FOCUS ON EVACUATIONS

Evacuation was the predominant category of cabin-related accidents during 2013. Relationships of interest related to this category include:

- In the majority (83%) of the evacuations following an accident, all of the occupants survived. However, in nearly half (46%) of these accidents, the aircraft was either destroyed or damaged beyond repair (hull loss).
- Over one-third (35%) of evacuations cited weak safety management on the part of the operator as a relevant latent condition.
- Over one-third of the evacuations (34%) were initiated following a runway excursion. Another 29% of evacuations resulted from gear-up landings / gear collapses. More than one-quarter (26%) of accidents involving an evacuation were preceded by a long / floated / bounced / firm / off-center / crabbed landing. Furthermore, 29% of aircraft accidents that resulted in an evacuation involved a flight crew error related to manual handling / flight controls.
- 29% of evacuations involved IATA member airlines.

CABIN SAFETY

Cabin operations play a critical role in the safety of air transport worldwide. Historically, the role of cabin crew was seen as limited to evacuations in a post-accident scenario. Although this remains an essential duty of cabin crew, today the role of cabin crew goes beyond passenger evacuations. Cabin safety deals with all activities that cabin crew must accomplish during the operation of an aircraft to maintain safety in the cabin. Cabin crew contribute to safe, effective, and efficient operations in normal, abnormal and emergency situations. As demonstrated in numerous events, cabin crew play an important role in preventing accidents and serious incidents, including but not limited to events such as such as an in-flight fire, unruly passenger or decompression.

It is for this reason that IATA focuses on cabin safety and continues to develop standards, procedures and best practices to ensure safety in all aspects of cabin operations. IATA works with airlines, manufacturers and other industry partners in raising standards and implementing best practices. Cabin safety is a critical component of aviation safety as is an airline's safety management system which includes proactive data collection and the ensuing prevention activities regarding:

- Cabin design and operation
- Equipment
- Procedures
- Cabin crew training
- Human performance and crew resource management
- Passenger management

IATA seeks to continuously contribute to the reduction of incidents / accidents, and costs associated with ensuring the safe operation of commercial aircraft. This is achieved through the:

- Development and promotion of recommended practices for the industry
- Analysis of worldwide trends and the initiation of corrective actions which offer tangible solutions
- Cooperation with aircraft manufacturers in developing technical installations, equipment and design
- Delivery of conferences and workshops that bring together a broad range of experts and stakeholders

CABIN SAFETY INITIATIVES IN 2013

Accident survivability has been increasing over the past five years. The data show that the survivability rate has been increasing in terms of the number of fatalities compared to the number of people onboard in accidents, from 85% in 2008 to 96% in 2013.

Upgraded cabin safety requirements as well as improved cabin crew training are among key factors contributing to this positive development. In line with its strong commitment to improving cabin safety, in 2013, IATA produced the Cabin Operations Safety Best Practices Guide.

Safety promotion and the sharing of safety information was another focus for Cabin Safety. In 2013, IATA hosted the very first Africa Cabin Operations Safety Seminar. This event offered delegates the opportunity to profit from the sharing of relevant cabin operations safety best practices and also to network with cabin operations safety specialists from Africa and around the world.

HEALTH AND SAFETY GUIDELINES - PASSENGER AND CREW

In the airline industry, health-related issues concerning passengers and crew are crucial in most activities and cover diverse matters. The IATA Medical Manual provides advice to the industry and other stakeholders on a wide range of medical issues. In addition, IATA also drafts guidelines specific to the health and safety of passenger and crew. The latest guidelines include:

- Procedures for suspected food poisoning on board
- Transport of a person who is, or may be, emitting radiation
- Passive passenger screening for passenger agents (pdf)
- Request form for passenger contact tracing
- Medical incident report form
- Death on board
- International transport of human remains
- Thermometers on board
- Oxygen delivery system for passengers (pdf)
- Cabin crew with insulin-treated diabetes (pdf)
- Cabin crew with seizure disorders (pdf)
- Insulin-treated diabetes: For assessment of fitness to work as Cabin Crew
- Suspected communicable disease - General guidelines for Cabin Crew
- Seizure disorders: Guidelines for assessment of fitness to work as Cabin Crew

To access the IATA Medical Manual, the most recent guidelines and other resources, go to: www.iata.org/health

IOSA & CABIN OPERATIONS SAFETY

The IATA Operational Safety Audit (IOSA) Standards Manual contains Section 5 – Cabin Operations which addresses key elements of cabin operations and safety. Section 5 – Cabin Operations includes the IATA Standards and Recommended Practices (ISARPs) for:

- Management and control
- Training and qualification
- Line operations
- Cabin systems and equipment

For more information on IOSA and to download the latest version of the IOSA Standards Manual (ISM), go to: www.iata.org/iosa

GLOBAL AVIATION DATA MANAGEMENT

IATA has recently introduced the Global Aviation Data Management (GADM) program as an expansion of the GSIC Project. This expanded program will allow IATA to provide the industry with more advanced, comprehensive, cross-database analysis. A key driver for safety improvements is data and information sharing. In 2013, GADM-STEADES produced the following analysis:

- Smoke and fumes (smells in the cabin & on the flight)
- On-board fire and smoke events
- Passenger smoking
- Unruly passengers
- Operational pressure
- Turbulence injuries

GADM – STEADES provides a business intelligence tool with a focus on reports and benchmarks. The Cabin Safety section provides cabin safety reference materials which will continue to evolve over time. For more information please go to: www.iata.org/gadm

Section 8

Report Findings and IATA Prevention Strategies

TOP FINDINGS, 2009-2013

Of the 432 accidents between ‘09 and ‘13:

- 30% involved IATA members
- 22% were fatal
- 78% involved passenger aircraft, 19% involved cargo aircraft and 3% involved ferry flights.
- 56% involved jet aircraft and 44% involved turboprops
- 42% resulted in a hull loss
- 58% resulted in a substantial damage
- 51% occurred during landing
- 38% of the fatal accidents occurred during approach

	Top 3 Contributing Factors
Latent conditions (deficiencies in...)	1. Regulatory oversight 2. Safety management 3. Flight operations
Threats	1. Aircraft malfunction 2. Meteorology 3. Airport facilities
Flight crew errors relating to latent conditions (deficiencies in...)	1. Manual handling/ flight controls 2. SOP adherence/ cross-verification 3. Failure to go around after destabilized approach
Undesired aircraft states	1. Long, floated, bounced, firm, off-centerline or crabbed landing 2. Vertical/Lateral/Speed deviation 3. Unstable approach
End states	1. Runway excursion 2. Gear-up landing/gear collapse 3. Ground damage

PROPOSED COUNTERMEASURES

Every year, the ACTF classifies accidents and, with the benefit of hindsight, determines actions or measures that could have been taken to prevent an accident. These proposed countermeasures can include issues within an organization or a particular country, or involve performance of front line personnel, such as pilots or ground personnel. They are valid for accidents involving both Eastern and Western-built jet and turboprop aircraft.

Based on statistical analysis, this section presents some countermeasures that can help airlines enhance safety, in line with the ACTF analysis of all accidents between 2009 and 2013.

The following tables present the top five counter measures which should be addressed along with a brief description for each.

The last column of each table presents the percentage of accidents where countermeasures could have been effective, according to the analysis conducted by the ACTF.

Countermeasures are aimed at two levels:

- The operator or the state responsible for oversight. These countermeasures are based on activities, processes and systemic issues internal to the airline operation or state’s oversight activities
- Flight crew. These countermeasures are to help flight crew manage threats or their own errors during operations

Countermeasures for other areas, such as ATC, ground crew, cabin crew or maintenance staff, are important but are not considered at this time.

COUNTERMEASURES FOR THE OPERATOR AND THE STATE

Subject	Description	% of accidents where countermeasures could have been effective
Regulatory oversight by the State of the Operator	States must be responsible for establishing a safety program, in order to achieve an acceptable level of safety, encompassing the following responsibilities: ■ Safety regulation ■ Safety oversight ■ Accident/incident investigation ■ Mandatory/voluntary reporting systems ■ Safety data analysis and exchange ■ Safety assurance ■ Safety promotion	**28%**
Overall crew performance	Overall, crew members should perform well as risk managers. Includes flight, cabin, and ground crew as well as their interactions with ATC.	**22%**
Safety management system (Operator)	The operator should implement a safety management system accepted by the State that, as a minimum: ■ Identifies safety hazards ■ Ensures that remedial action necessary to maintain an acceptable level of safety is implemented ■ Provides for continuous monitoring and regular assessment of the safety level achieved ■ Aims to make continuous improvements to the overall level of safety	**22%**
Monitor/ cross-check	Crew members should actively monitor and cross-check flight path, aircraft performance, systems and other crew members. Aircraft position, settings and crew actions are verified.	**19%**
Flight operations: Training systems	Omitted training, language skills deficiencies, qualifications and experience of flight crews, operational needs leading to training reductions, deficiencies in assessment of training or training resources such as manuals or CBT devices.	**15%**

COUNTERMEASURES FOR FLIGHT CREWS

Subject	Description	% of accidents where countermeasures could have been effective
Monitor/ cross-check	Crew members should actively monitor and cross-check flight path, aircraft performance, systems and other crew members. Aircraft position, settings and crew actions are verified.	**19%**
Contingency management	Crew members should develop effective strategies to manage threats to safety.	**10%**
Automation management	Automation should be properly managed to balance situational and/or workload requirements	**6%**

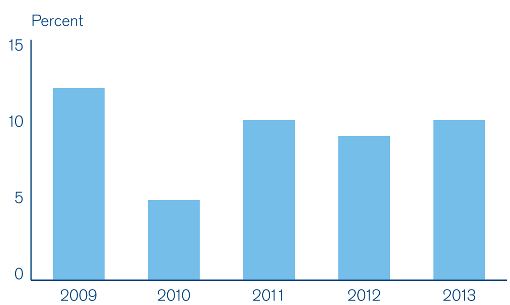
ACTF DISCUSSION & STRATEGIES

Loss of Control In-flight

Background:

The generally high reliability and usefulness of automated systems poses the question of whether the high amount of flight hours spent in fully automated flight is responsible for pilots being increasingly reluctant to revert to manual flying skills when needed. While aircraft are highly automated, the automation is not designed to recover an aircraft from all unusual attitudes. Therefore, flight crews must still be capable of manually operating the aircraft, especially in edge-of-the-envelope situations.

Flight crews are seemingly more apprehensive about manually flying their aircraft or changing the modes of automation when automated systems fail, when aircraft attitudes reach unusual positions, or when airspeeds are not within the appropriate range. This is due in no small part to not fully understanding what level of automation is being used or the crew's need to change that level due to the level of automation being degraded for a given reason. The graph below indicates the percentage of all accidents that were Loss of Control In-flight (LOC-I) over the past five years.



Loss of Control In-flight as a percent of total accidents

Discussion:

The last five years have seen an average of approximately eight LOC-I accidents per year. These accidents come from a variety of scenarios and it is difficult to single out the most critical scenario. However, looking at accident data, LOC-I is often linked to an operation of the aircraft well below stall speed. Even with fully protected aircraft, stall awareness and stall recovery training, as well as approach to stall recovery training, needs to be addressed on a regular basis. It is recommended that airline training departments pay attention to the contents of the Upset Recovery Toolkit, which is still valid and which contains very useful information. Upset recovery training - as with any other training - largely depends on the skills and knowledge of the instructor. It is therefore recommended that the industry place a particular emphasis on instructor training.

Upset recovery training, aerobatics and unusual attitude training included as part of an operator's flight crew training syllabus gives crew a chance to experience potentially dangerous situations in a safe and controlled environment, which better prepares them if they should encounter a similar situation while flying on the line. Regrettably, current flight simulator technology is limited in how accurately it can reproduce these scenarios.

Somatogravic illusion (the feeling where the perceived and actual acceleration vectors differ considerably) can create spatial disorientation and lead to catastrophic events such as CFITs. Training is available to assist crews facing spatial disorientation situations. Simulator training may be of limited value for somatogravic illusions. The simulator is an illusion already so may be unrepresentative if we attempt to reproduce such illusions.

In modern aircraft, failure of a relatively simple system (e.g., radio altimeter) may have a cascade effect that can result in a catastrophic outcome. Crew training should emphasize solving complex, cascading failures that originate from a single source.

Automation is a tool that can be helpful to flight crew, however it is never a replacement for the airmanship skills required to operate the aircraft. Training for scenarios that could lead to an upset (e.g. low-energy approaches, engine failures, etc.) must be continuously reinforced to address areas of safety concern, as well as the usual training protocols which achieve a baseline proficiency in aircraft handling. There was one accident in 2012 which resulted in a considerable portion of the vertical stabilizer being sheared from the airframe, yet the flight crew managed to maintain control of the aircraft and perform a safe landing.

Recommendations to Operators:

Operators are encouraged to follow up on current research activities, such as the SUPRA-Project (Simulation of Upset Recovery in Aviation) by NLR/TNO in The Netherlands and activity by the International Committee for Aviation Training in Extended Envelopes (ICATEE), established by the Flight Simulation Group of RAeS. ICAO and SkyBrary also have materials dealing with LOC-I.

Airlines should consider the introduction of upset recovery training, aerobatic training or other unusual attitude recovery training into their syllabus to better prepare flight crews for similar events in routine operations. Training should be designed to take pilots to the edge of the operating envelope in a safe environment so that they are better prepared to deal with real-life situations.

Training syllabi should be updated to include abnormal events that flight crew may routinely face (e.g., stalls and icing) as well as conventional training such as engine failure on take-off.

Operators should consider incorporating procedures to allow for manual flying of the airplane in line operations, under some circumstances. Such operations should be encouraged to get flight crews comfortable with manual control and to exercise these skills on a regular basis. The FAA SAFO 13002 Manual Flying Skills outlines recommendations that include all phases of operations: initial, recurrent, initial operation experience, and operator guidance for "Line Operations when appropriate". Efforts to restore and maintain manual flying skills must be comprehensive and ongoing. Periodic simulator training should include unusual attitude exercises that are realistic to include extremes of center of gravity, weight, altitude, and control status.

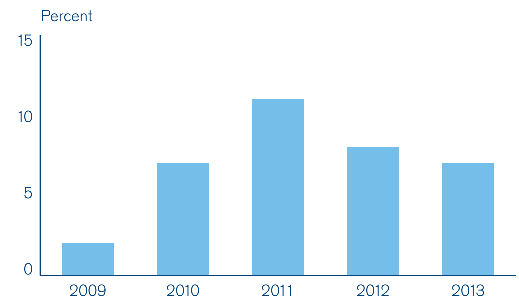
Operators should be aware of limitations of simulators to represent conditions out of the flight envelope as they have not been calibrated against flight data. The simulator response may differ from what is experienced in the aircraft, thus there is a possibility of providing negative training.

Training should also not rely too much on certain aircraft flight control protections. Increased focus on training scenarios under degraded flight control protection should be considered.

Controlled Flight into Terrain

Background:

Controlled Flight into Terrain (CFIT) continues to be an issue for the aviation industry. Six such accidents occurred in 2013, on par with the average for 2009 to 2013.This despite most commercial aircraft being equipped with technology to prevent such occurrences. The graph below indicates the percentage of all accidents that were CFIT over the past five years.



Controlled Flight into Terrain as a percent of total accidents

In the period from 2009 to 2013, 52 percent of CFIT accidents were known to involve the lack of a precision approach. There is a very strong correlation between the lack of an instrument landing system (ILS) or state-of-the-art approach procedures, such as performance-based navigation (PBN) and CFIT accidents.

During this same period, 59 percent of aircraft were not equipped with enhanced ground proximity warning systems (EGPWS).

Several accidents in this period involved aircraft that were retrofitted with GPS equipment or crews that used unapproved navigation equipment. With retrofits the navigation source switching can become more complex and an incorrect switch position can be overlooked easily by the crew. In one case, an unapproved GPS navigation system was used. The database of the unapproved system used a different geodetic coordinates system so the final approach path was off by more than 100 meters.

Discussion:

The lack of precision approaches has been noted as a major contributing factor to CFIT accidents. The implementation of precision approaches or PBN approaches is seen as a method to reduce the risk of CFIT accidents. Where this is impractical, the use of Continuous Angle Non-Precision Approaches (CANPA) can help with the transition from approach to landing by providing a more stable descent profile than traditional "dive and drive" methods used for non-precision approaches.

Some airlines are prohibiting circling approaches in favor of using RNAV or RNP approaches instead. Some airlines discuss the operational impact of circling approaches and perform a risk evaluation. Forward knowledge of terrain through prior experience does not eliminate the need to adhere to EGPWS warnings. It was predicted that at some point a pilot will ignore a valid EGPWS warning, believing to know their actual position relative to the ground, and that this would lead to a CFIT accident.

Most pilots do not appreciate how close the approaching terrain is when the EGPWS alarm is sounded. There is often little or no visual reference available and a very short time to react.

Be mindful of operational pressures and manage them properly. Trust the safety equipment provided in the aircraft. Ensure proper QNH settings on early-generation EGPWS units to avoid false warnings that could lead crews to suppress alarms (e.g., placing the system into "TERRAIN" mode). Modern EGPWS systems use GPS altitude to reduce the rate of these instances.

Recommendations to Operators:

Operators should support the concept of CANPA to reduce the risk of approach and landing CFITs, and train their pilots to select CANPA instead of "Dive and Drive".

Airlines should ensure that as many aircraft as possible are equipped with approved GPS so that accurate positioning and altitude data is available. In the case of retrofitted navigation systems through supplemental-type certificates (STC), airlines should pay particular attention to the human-machine interface requirements, so that navigation source switching does not become a hazard. A proper change management process can help identify and mitigate risks that are created by the introduction of the new hardware (e.g., by making the appropriate changes to SOPs).

Crews are encouraged to use Regulator, OEM and Operator-approved navigation equipment only. Unapproved equipment can lead to a false impression of high navigation accuracy. All crewmembers should be aware of the nature and limitations of the safety systems installed. For example, it is important to understand the difference between terrain information derived from a navigation database and that which is derived from a direct reading sensor such as radar altimeter. Effective procedures, and individual discipline, also need to address the issues of which approach procedure and track to choose, what data to follow, and how to handle being off track. Effective CRM training and drills should mitigate errors and fatigue, and enhance the escape from dangerous situations. With modern NAV displays driven by GPS and FMS, it is easy to assume that the desired track line is correct and safe.

Airlines are encouraged to maintain their equipment and ensure that the terrain/obstacle data being used by the system is current. Airlines should develop procedures to ensure that the EGPWS database is kept as up-to-date as possible. In addition, operators are recommended to ensure that the terrain warning system and its sensors are also up to date. Each operator should ensure that the latest modifications are incorporated in their particular 'TAWS' or EGPWS computer and with GPS providing aircraft position data directly to the computer. These provide earlier warning times and minimize unwanted alerts and warnings.

Flight operations departments are encouraged to review their circling approach policies and are encouraged to reduce the number of circling approaches, possibly through increasing the visibility requirements. They are also encouraged to conduct a risk analysis of the various approach options. Operators are advised to use published Global Navigation Satellite System (GNSS) approaches rather than "circle to land" when a certified GPS is installed on board and the crew is trained for the procedures.

Airlines are encouraged to familiarize theirs crews with the proximity of terrain once the EGPWS has triggered an alarm (perhaps use a simulator with a very high fidelity visual system). Many crews falsely believe that there is ample time to react once an EGPWS alert is sounded. While many operators include this as part of their training program, it is essential information that should be included in all training programs.

Remind crews that if an EGPWS alert triggers during an instrument approach, the alert should be respected at all times. Incorrect altimeter settings, incorrect or missing low temperature adjustment, radio altimeter failures, etc. can all lead to cases where the true altitude of the aircraft is not known by the crew.

Recommendations to Industry:

The industry is encouraged to further their work on implementing PBN approaches in areas where a precision approach is not practical. Where these are not available, it is recommended to review the adoption of Continuous Angle Non-Precision Approaches (CANPA) for non-precision approaches.

CFIT accidents are occurring mainly in areas of the world where the use of Terrain Awareness Warning Systems (TAWS) is not mandatory. It is recommended that these states mandate the use of TAWS in air transport aircraft as it demonstrates a clear benefit for CFIT reduction. These aircraft will need to be fitted with accurate navigation features (i.e., stand alone or, better, dual GPS for both navigation and terrain surveillance benefit). Most air transport aircraft are fitted or could be fitted with such systems. Without an accurate position it's more difficult to have an appropriate TAWS functioning.

Authorities are recommended to investigate mandating procedures that ensure EGPWS databases are kept accurate and up-to-date. This has to be emphasized in light of two cases in 2011 were the EGPWS database was never updated. These updates are critical as they include terrain and runway ends.

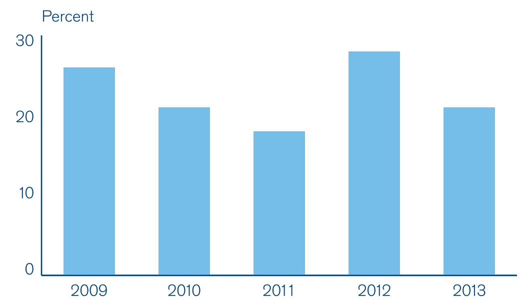
In some countries an EGPWS supplier has to contact the state to get access to terrain data. Governments are encouraged to automatically provide to manufacturers the respective terrain data in cases where a new airport opens.

Authorities are encouraged to comply with ICAO recommendations and guidelines regarding PBN implementation.

Runway Excursions

Background:

Runway Excursions continue to be the most frequent type of accident year-over-year since 2008. This year, runway excursions represented 17 of 81 accidents or 22 percent of all accidents in 2013. The following graph indicates the percentage of accidents classified as runway excursion over the previous five years., Runway excursions include landing overruns, take-off overruns, landing veer-offs, take-off veer-offs and taxiway excursions meeting the IATA definition of an accident. It is worth noting not all runway excursions meet this definition. Therefore, other studies which include serious incidents may indicate a higher number of events.



Runway Excursions as a percent of total accidents

Over the five year period from 2009 to 2013, 87 percent of runway excursions occurred in the landing phase of flight. There are many factors noted to have contributed to runway excursions from 2009 to 2013. Long, floated or bounced landings were noted in 45 percent of all landing-related runway excursion accidents during this period. Known or suspected unstable approaches were a factor for 16 percent of landing-related runway excursions. Contrary to trends seen in previous years, there is an increase in the number of runway excursions occurring following stable approaches. Errors in the manual handling of the aircraft were noted to have contributed to 39 percent of runway excursions. For unstable approaches this is a five percent drop from 2012 and manual handling errors dropped by six percent from 2012. No significant conclusions should be drawn from these particular reductions, but this does indicate a positive trend which should be watched.

External threats are also a factor that should be noted. Contamination of runways, such as that resulting from standing water, ice or rubber deposits, contributed to 32 percent of all runway excursions. High or gusty winds and crosswinds were noted as a factor in 23 percent of accidents. This can include cases where incorrect wind information is communicated to the flight crew. Airport facilities and meteorology represent the largest components for environmental factors; 20 percent of runway excursions were linked to aircraft malfunctions. While the occurrence rates of aircraft flying unstable approaches or landing on contaminated runways are low, the proportion of runway excursions from those precursors remains high.

While there was a correlation between runway excursions and wet or contaminated runways, there is also need for flight crews to be conscious of the risk of excursion even in favorable conditions. Sixty-eight percent of the excursions occurred in dry runway conditions. This underscores the need for crews to be vigilant in the landing phase of flight, regardless of the runway conditions.

Discussion:

Airlines can better use Flight Data Analysis (FDA) programs to understand the root causes of unstable approaches:

- FDA can help the airline determine correlations of interest between unstable approaches and specific airports (e.g., ATC restrictions), individual pilots, specific fleets, etc.
- Personal FDA debriefs on the request of a flight crew member should be encouraged

Airlines should address not only unstable approaches but also destabilization after being stabilized, especially at low altitude (below MDA/DH) and consequently go-arounds / rejected landings.

Being stable at 500 feet does not guarantee that the landing will occur -– a go-around may still be necessary.

Auto-land and other automation tools only work within certain limitations which need to be well understood by the crew.

Recommendations to Operators:

These highlights could work as defenses for avoiding runway excursions:

1. Landing in the touchdown zone
2. Defining the touchdown aiming point as the target
3. Parameters of stable approach based on the manufacturer information
4. Deviation call outs by the Pilot Monitoring
5. Recommend the use of metrics to measure SMS affectivity and ensure continuance improvement.
6. Implement a flight data monitoring system.
7. Validate the FDM parameters with the flight Ops department based on manufacturer's criteria.

Stable approaches are the first defense against runway excursions. The final, more important, defense is landing in the touchdown zone.

Airlines are recommended to modify their approach procedures to call out "STABILIZED" or "NOT STABILIZED" at a given point on the approach to ensure a timely go-around is carried out when necessary. This type of callout is especially useful in situations where a high crew social gradient (social power distance from a new or unassertive first officer to a domineering or challenging captain) exists, or when cultural conditioning could hinder crew member communication. Note: some companies prefer the use of the callout "GO AROUND" if stabilization criteria are not met at their respective gates. Bear in mind that, even when stabilization criteria are met at certain points, destabilization can require a go-around at any time. In this context, a company backed "no fault" go-around policy would establish crew member confidence about making the decision to go-around when established conditions make a go-around necessary.

Airlines are encouraged to set windows in the approach at specific points (e.g. "Plan to be at X feet and Y knots at point Z"). This is especially useful at airports with special approaches. Brief key points in each window and how they are different from the standard approach procedure. Establish a policy specifying that if these parameters are not met a go-around must be executed.

Pilots should make an early decision to use the maximum available braking capability of the aircraft whenever landing performance is compromised, seems to be compromised or doubt exists that the aircraft can be stopped on the runway. Pilots should be mindful of what is called 'procedural memory'. It is recommended that training departments address the issue. Pilots must be aware that late application of reverse thrust is less effective than early application on account of the time required for engines to spool up and produce maximum thrust. The application of reverse thrust (when installed) is paramount on braking action challenged runways – it is much more effective at higher speeds when aircraft braking is not as effective on wet or slippery runways.

Investigate technology to help crews determine the actual touchdown point and estimate the point where the aircraft is expected to stop. Various manufacturers offer or are developing these systems. Work is ongoing to enhance runway remaining displays on both heads-up display (HUD) and primary flight display (PFD) panels. The airline industry should monitor the validity of predicted stopping indicators, especially in situations of contaminated surfaces or less than optimum performance of brakes, spoilers, and thrust reversers. While a display can give a prediction based upon the deceleration rate, it cannot anticipate changes in surface friction which will result in actual performance that is less than predicted.

Operators are advised to conduct a field survey to determine the actual landing and take-off distances in comparison to their predicted (calculated) values. Consideration for runway conditions at the time of the survey should be incorporated. This data may be obtainable from the operator's FDA program.

Operators should encourage flight crews and dispatchers to calculate stopping distances on every landing using charts and tools as recommended by the National Transportation Safety Board (NTSB) and described by the FAA in their Safety Alert for Operators (SAFO) 06012. Crews should understand and build margins into these numbers.

Operators are encouraged to set a safety focus where actual take-off/landing distances are compared with calculated take-off and landing distances to give pilots a feel for how big a bias there is between data from the manufacturer and the average pilot. For example, if the calculation shows a stop margin of XX meters at V1, then use FDA data and compare what the actual stop margin at V1 was on this particular flight.

Recommendations to Industry:

1. Encourage implementation of SMS for all commercial airlines and maintenance facilities.
2. Encourage a policy of a rejected landing in the case of long landings.
3. Measure the long landings at the simulators.
4. Require training in bounced landing recovery techniques.
5. Train pilots in crosswind and tailwind landings up to the maximum OEM-certified winds.

6. Encourage airlines to develop campaigns to establish SOPs as culturally normative actions.

Technology to assist in landing during severe weather is available, but is not widely installed. Airports authorities are encouraged to cooperate with other industry and commercial stakeholders to see if a viable safety and business case can be created to install such resources.

Regulators and airports are encouraged to use RESA (Runway End Safety Area), EMAS (Engineered Material Arrestor System), and similar runway excursion prevention technologies and infrastructure to help reduce the severity of runway excursions. Where these systems are in place, their presence should be communicated to crews by indicating them on charts or, possibly, including signage that indicates EMAS ahead. Regulators should also investigate standardizing runway condition reporting in an effort to simplify decisions faced by flight crews when determining required runway length for landing. Standardized reporting must be harmonized with the airplane performance information supplied by airplane manufacturers.

Airports are encouraged to improve awareness of the touch-down zone. Borrowing time-tested military concepts, such as touch-down zone markings every 1000 feet, can greatly improve a flight crew's situational awareness during landing rollout.

Scientific communities are encouraged to evaluate the usefulness of current technologies with regards to accurate and timely measurement of winds and wind shear to determine how this information can be relayed to flight crews to increase situational awareness.

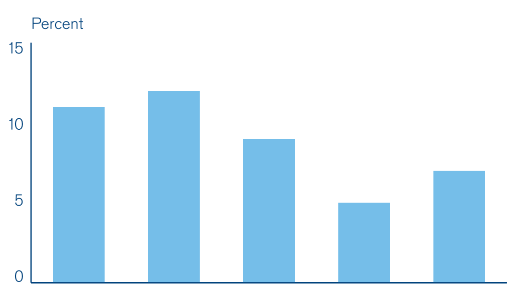
Airports should refrain from publishing requirements limiting the use of reverse thrust due to noise issues because this practice contributes to runway excursions as crews do not utilize the full capability of stopping devices. This is particularly true at airports with high-intensity operations.

Aircraft Technical Failures and Maintenance Safety

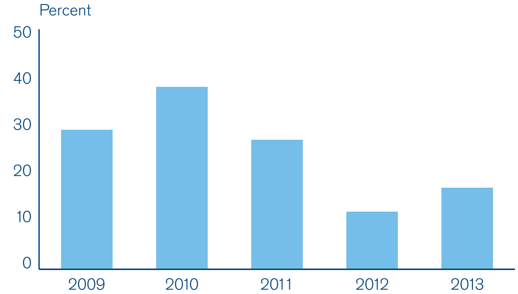
Background:

Data analyzed following the accident classification indicates an improvement and a positive trend. However, deficient or incomplete maintenance practices continue to contribute to industry accidents. The following graphs indicate the percentage of accidents citing known errors in maintenance operations or technical malfunctions of the aircraft:

In 2013, six accidents (7%) had maintenance-related issues while 22 percent of accidents cited technical problems



Maintenance Issues



Technical Problems

Discussion:

Commercial pressures have forced virtually all airlines to outsource at least a portion of their heavy and/or routine maintenance operations.

The capability of any maintenance and repair organization (MRO) chosen to perform an airline's maintenance must match the airline's size (both number of aircraft and number of flights) and their normal maintenance practices. Very few MROs are capable of completing a large work package (due to deferred maintenance on MEL items) to a high standard under normal airline time pressures. MRO certification is not a guaranty of work quality.

After a heavy maintenance check, many larger airlines will have a "shakedown cruise" to gauge the quality of work performed by the MRO and determine the short-term (e.g., 30 day) reliability of the aircraft. This helps to identify issues before the aircraft goes back into service and ensures a higher degree of reliability and completion factor for the airline.

In many cases, too much effort and legislation is put into oversight of the documentation trail, rather than the repair work being physically performed on the aircraft. For example, whoever certifies an aircraft as airworthy must be certificated, however those who perform maintenance the work do not necessarily have to possess any licensing credentials. There are some anecdotal cases where the primary concern was that the paperwork for a work-package was not done, where the when in reality the work itself had not been completed.

The issue of aircraft parts was also discussed. This aspect ties into both bogus parts and what are termed as "rogue parts". A rogue part is one that is reused without being properly certified or checked for serviceability. For example, a part may be written-up in a crew aircraft maintenance discrepancy report. However, after the part receives a clean bench check, it is placed back on the "serviceable" shelf for re-use at a later date. Another interpretation of a rogue part is an old part (sometimes as much as 30 years old) being inappropriately refurbished and then certified as serviceable. Parts need to be checked for serviceability regardless of age or certification status.

Maintenance configuration control was also discussed. Specifically, are the installed parts in the aircraft supposed to be there according to the actual in-service documentation? This issue is not limited to older aircraft as recent models can also be affected by similar lapses. There are also anecdotes regarding operations replacing parts as a means to extend MEL periods due to financial constraints. This is separate from the rotation of parts for the purpose of troubleshooting.

Maintenance human error continues to be a leading factor in maintenance aircraft incident events. To address these errors the industry needs to identify the root cause of such events. Maintenance departments should adopt similar safety programs and tools as are used during Flight Operations. For example, the principles of Crew Resource Management (CRM) can be applied to Maintenance Resource Management, Line Oriented Safety Audits (LOSA) can be developed for maintenance and ramp operations, and Fatigue Risk Management Systems (FRMS) can be implemented for Maintenance. All of these programs and tools can help proactively identify the root cause of errors so that proper mitigation steps can be taken to prevent these errors from becoming significant events.

Flight crews also have a role in maintenance-related safety. The number and combination of MEL items, combined with other factors (e.g., weather) can lead to degraded safety levels. Also, temporary revisions to procedures are affected depending on the MEL items. Operators are reminded that MELs are meant as a way to legally fly the aircraft to a location where it can be repaired, and not as a maximum time limit on how long the aircraft can remain in service before maintenance must be performed. Ensuring this aspect of maintenance-related activities is well understood within its own flight and maintenance organizations will ensure that aircraft are repaired correctly and on-time. Flight crews should not be forced to make operational decisions and "push" their limits while flying revenue flights.

Recommendations to Operators:

Functional check flights (FCF) or shakedown cruises after heavy aircraft maintenance are recommended to verify that the aircraft is operating normally. This will also increase in-service reliability and enhance the airline's completion factor after heavy maintenance is performed.

The Flight Safety Foundation (FSF) has published a FCF Compendium document containing information that can be used to reduce risk. The information contained in the guidance document is generic and may need to be adjusted to apply to an airline's specific aircraft. Operators are encouraged to retrieve this material.

Maintenance Repair Operator (MRO)/Airline Maintenance departments should implement a LOSA system for their maintenance activity.

Continuation of Airline Operation during Severe Weather

Background:

Airline operations may be completely suspended by severe weather in some parts of the world. Meteorological threats were identified as factors in 24 percent of accidents in 2013 and 28 percent of accidents during the period of 2009 to 2013. Aerodromes are encouraged to provide aviation weather services to Air Traffic Services (ATS) units, airline operators, flight crew members, dispatchers and airport management by supplying the necessary meteorological information.

Discussion:

Weather has a large-scale effect on operations. Operators need to be aware of commercial factors relating to weather delays such as public expectations and passenger compensation criteria (where in effect).

Aerodrome's ATS observations and forecasts are to be disseminated to aircraft pilots and flight dispatchers for pre-flight planning.

Auto-land and other automation tools only work within certain limitations. Technology to assist in landing during severe weather is available but is not widely installed.

All aerodromes need to issue alerts for low-level wind shear and turbulence within three nautical miles of the runway thresholds for relay by air traffic controllers to approaching and departing aircraft.

Continuous improvement of various warning services is needed to develop capabilities for real-time downlink of weather data obtained by aircraft and uplink of weather information required in the cockpit.

Recommendations to Operators:

Operators should consider tools that allow dispatch offices to provide crews with the most up-to-date weather information possible.

Ensure that aerodrome's ATS observations and forecasts are disseminated to aircraft pilots and flight dispatchers for pre-flight planning.

Airlines should develop a contingency plan, involving dispatch and crew support, that clearly defines guidance at an organizational level on who is responsible to cease operations.

The applicability of limits for wind and gusts should be clearly defined in the Operations Manual.

All aerodromes need to have a meteorological office that issues alerts of low-level wind shear and turbulence within three nautical miles of the runway thresholds for relay by air traffic controllers to approaching and departing aircraft.

Recommendations to Industry:

Scientific communities are encouraged to evaluate the usefulness of current technologies with regards to accurate and timely measurement of gusty winds and how such information can be quickly relayed to flight crews to increase situational awareness.

Develop capabilities for real-time downlink of weather data obtained by aircraft and uplink of weather information required in the cockpit

Crew Resource Management

Background:

Social and communication skills are a vital part of overall crew performance. Ultimately, an electronic system cannot be designed for every possible threat and efficient crew interaction is critical for the mitigation of potential threats.

Discussion:

Crew Resource Management (CRM) continues to be an important factor in aviation safety, especially in more conservative social environments. While implemented at many operators, CRM is not universally applied and many airlines have ineffective or no formalized CRM training programs in place.

In cultural environments where a high social gradient exists, strict standard operating procedures (SOPs) help establish clear lines of communication and allow for first officers to pass critical situational information to the captain without compromising their position or causing the captain to "lose face".

Effective crew pairing with respect to seniority and experience can promote optimal conditions for crew performance.

Recommendations to Operators:

CRM training should include and emphasize assertiveness and identify specific cases where the social gradient or rank distance between the captain and first officer is high enough to impede effective communications. Focus on specific cultural factors when applicable.

Encourage captains to allow first officers to demonstrate assertiveness and leadership. Communicate that despite rank or position, the captain is still human and is capable of making mistakes. Ensure that captains understand they are not infallible.

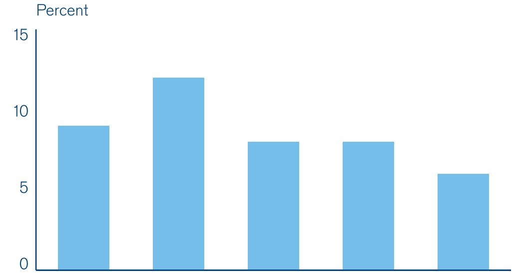
Specific call-outs of information or decision requirements at critical points in the flight may help the first officer to overcome the social gradient between the crew members. Properly developed SOPs with clear instructions may empower first officers to take over the flight controls when the situation requires assertiveness.

A process for debriefing CRM issues that arose during line operation will give the individual pilot essential feedback on his/her performance.

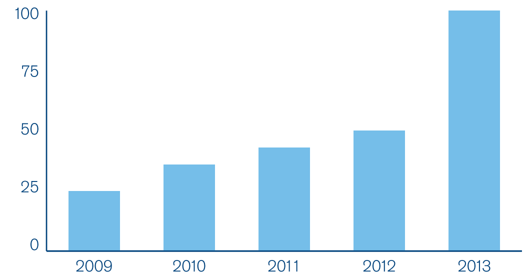
Go-Arounds

Background:

Ten percent of accidents between 2009 and 2013 cited an unstable approach as a factor. A graph of the percentage of accidents with unstable approaches as a factor over the last five years is included below.



Unstable Approach



Continued Landing following Unstable Approach

The ACTF noted a correlation between unstable approaches and accidents due to crews not performing a go-around when required. The graph of the previous five years percentage of accidents where it was noted that the crew continued to land following an unstable approach as a factor is included above.

Discussion:

The go-around procedure is rarely flown and is a challenging maneuver. Crews must be sufficiently familiar with flying go-arounds through initial and recurrent training.

Somatogravic head-up illusions during the unfamiliar forward acceleration in a go-around can lead to the incorrect perception by the flight crew that the nose of the aircraft is pitching up. This illusion can cause pilots to respond with an inappropriate nose down input on the flight controls during the execution of a go-around. Such responses have led to periodic accidents.

There are also cases when the crew engage the autopilot to reduce the workload, but instead put the aircraft in an undesired situation due to a lack of situational awareness with the automation.

Airlines should not limit training scenarios to the initiation of a go-around at the approach minimum or missed approach point. Training scenarios should focus on current operational threats as well as traditional situations.

Recommendations to Operators:

Airlines are recommended to modify their approach procedures to call out "STABILIZED" or "GO-AROUND" at a given point to ensure a timely go-around is carried out. While a STABLE or STABILIZED callout might be required at either 1000 feet or 500 feet above touchdown, the "GO-AROUND" command can and must be made at any time prior to deployment of thrust reversers.

When developing crew training programs, operators are encouraged to create unexpected go-around scenarios at intermediate altitudes with instructions that deviate from the published procedure; this addresses both go-around decision-making and execution. The training should also include go-around execution with all engines operating, including level-off at a low altitude and go-arounds from long flares and bounced landings. Operators should also consider go-arounds not only at heavy weight and one engine inoperative, which are the typical scenarios, but also at light weight with both engines operative in order to experience the higher dynamics. Crews should fly the go-around pitch and Flight Director bars and adapt the thrust to remain within flight parameters.

Training should emphasize the significance of thrust reverser deployment for a go-around decision. From a technical point of view, a go-around may always be initiated before reverser deployment and never after reverser application.

Introduce destabilized approach simulator training scenarios, which emphasize that deviations from the stabilized approach profile at low altitudes (below MDA/DH) should require execution of a go-around.

It has often been said that failure to execute a go-around is usually associated with a mind set to land. There are very few situations where a go-around is not an option and it is important for crews to have an understanding of when they must land and when to leave themselves an out.

Airlines should incorporate training on somatogravic illusions during the initiation of a go-around. Simulators that combine the possibilities of both the hexapod and the human centrifuge are already available and in use, (e.g., for military training). They can be used to demonstrate the illusions during go-around initiation and train pilots for a correct reaction on the heads-up illusion. As preventive means, crews are recommend to brief the go-around, not delay it, respect minima, monitor the flight parameters and fly the go-around pitch and the Flight Director bars where available.

Airlines should consider the time loss due to go around as necessary for safe operations. Therefore, commercial pressure should not be imposed on flight crews. Pilots may be reluctant to go-around if they feel the fuel state does not support it. A go-around should be considered as potentially occurring on every flight and so the flight must be fueled to allow for a go-around without resulting in a low-fuel situation. A no fault go-around policy should be promoted by the operators. If pilots are fearful of disciplinary action they will be less likely to go around when they should.

Recommendations to Industry:

Authorities should examine if initial go-around altitudes may be increased wherever possible to give flight crews additional time to both reconfigure the aircraft and adjust to their new situation.

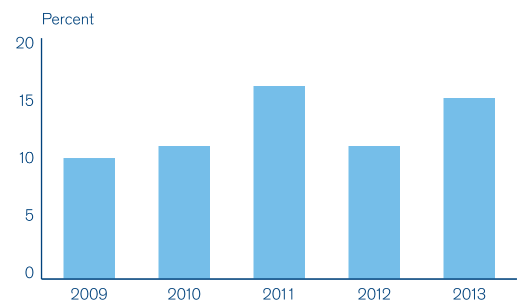
Industry should support the development of operational feasible simulators which can generate sustained g-forces for generic go-around training with regard to somatogravic illusions.

Air traffic controllers should be reminded that any aircraft might execute a balked landing or missed approach. This will involve startle and surprise for the ATC just as it might for the flight crew involved. They should understand that the flight crew will immediately be involved in stabilizing the flight path, changing configuration, and communicating with each other. The flight crew will communicate with ATC as soon as they are able and ATC should be prepared to clear other traffic, provide or approve an altitude and direction of flight. They should also understand that the aircraft might be entering a fuel critical state such that routing and sequencing for diversion or subsequent landing must be without undue delay.

Ground Operations & Ground Damage Prevention

Background:

Ground damage continued to be one of the primary categories of accident this year, representing 15 percent of 2013 accidents and 13 percent of accidents during the period of 2009 to 2013. The graph below indicates the percentage of ground damage accidents over the previous five years. Ground damage continues to be a major cost for operators, and requires a cooperative safety approach with all involved parties including airlines, ground service providers, airport authorities and government.



Ground Damage

Discussion:

Actual hands-on experience with a real aircraft is required to accurately gauge the size and position of the wings and airframe when moving on the ramp. This is particularly true as new aircraft with larger wingspans are being added to airline fleets. The risk of ground events is expected to increase as growth in traffic outpaces growth in airport capacity resulting in more aircraft operating in a limited space.

Crews need to exercise increased vigilance during taxi operations in congested airports, near challenging gates or stands in close proximity to obstacles. Operators and crews should note:

- Not to rely solely on ground marshals or wing walkers for obstacle avoidance and/or clearance while taxiing.
- Turboprops can be especially prone to ground damage. Several cases of turboprops taxiing into ground carts were noted.
- ATC clearance to taxi is not an indication that it is safe to begin taxiing - surroundings must be monitored at all times.

Ground staff should be informed to respect lines and other markings depicting protected zones. As surface markings can differ from one airport to another, the ground crew is better positioned to assure the safe positioning of the aircraft when approaching a parking spot or gate. Issues such as ground vehicles failing to give right of way to moving aircraft, movable stands, carts and other equipment being placed incorrectly, not being removed, or blowing into moving aircraft continue to affect safety on the ground.

Ground markings should be clear and well understood by ramp workers. Confusing and/or overlapping lines can contribute to improperly positioned aircraft and result in ground damage. Lines can be difficult to see in wet conditions; this can be helped through the use of contrast painting (i.e., a black border to taxi lines where the surface is concrete).

Damage to composite materials will not necessarily show visible signs of distress or deformation. Engineering and maintenance must remain on constant vigilance when dealing with newer aircraft that contain major composite structures.

Due to hesitation of some ground staff in submitting ground damage reports, the data available is not enough to be more effective in finding accident precursors, identifying hazards and mitigating risks.

All service providers such as aircraft operators, maintenance organizations, air traffic service providers and aerodrome operators need to be compliant with ICAO SMS Doc. 9859 to strengthen the concept of aproactive and predictive approach to reducing ground damage events.

IATA Safety Audit for Ground Operations (ISAGO) certifications may benefit all service providers in understanding high risk areas within ground operations in all aerodromes.

Recommendations to Operators:

Ensure crews receive taxi training that includes time spent in real aircraft (with wing walkers indicating the actual position of the wings to the pilot) to help accurately judge the size of the aircraft and its handling on the ground.

Ensure crews inform ATC of aircraft position while waiting to enter the ramp area in preparation for a final parking slot to increase situational awareness and indicate that the aircraft may not be fully clear of the taxiway.

Consider the utilization of stop locations for aircraft entering the ramp similar to those used while leaving ramp areas. Stop locations should ensure adequate clearance from movement areas while transitioning from ground control.

Lapses in SOPs such as not setting the parking brake can lead to ground damage and even ramp injuries or fatalities. Crew training with regards to effective communication during the taxi procedure should be applied and reinforced.

Inform crews of the unique nature of composite materials and reinforce that severely damaged composite materials may show no visible signs of distress.

Train crews regarding the handling and responsibilities of taxi instructions. The taxi clearance does not ensure that no obstacles are present for the crew. The crews must be aware of their surroundings and know to request assistance when in doubt; particular attention must be paid to wingtip clearances.

Ensure compliance with ICAO Safety Management System (SMS) Document 9859.

Encourage all ground staff to report all ground damage events, incidents or violations through the Safety Reporting System and/or Aviation Confidential Reporting System (ACRS).

Recommendations to Industry:

Lack of information on charts, in particular airport taxi charts, can lead to ground damage. Chart providers are encouraged to include as much information as possible on charts while maintaining legibility.

Additionally, potential hazards and areas of confusion must be identified clearly.

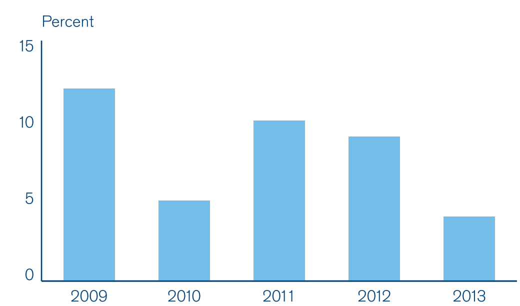
Manufacturers are asked to investigate the use of technology to assist crews in determining the proximity of aircraft to obstacles. Similar technology has been available in automobiles for several years and would be extremely useful in low-visibility situations or when the pilot's view is obstructed.

While a flight crew can be expected to avoid collisions with fixed structures and parked aircraft by maintaining the correct relationship with taxi lane markings, the situation will be improved with enhancements that provide both moving real time ground mapping as well as real time traffic display. Technology exists for every aircraft and ground vehicle to emit position information. It is expected that ADS-B out and in will provide the necessary ground collision prevention in conjunction with well-engineered ramps and taxi lanes.

Hard Landings

Background:

Four percent of the accidents in 2013 and eight percent during the period of 2009 to 2013 involved hard landings. A graph of the previous five years' percentage of accidents due to hard landings is included below.



Hard Landing

Frequent contributing factors to hard landings in the last five years were meteorological factors, typically related to wind or wind shear (38% of all hard landing accidents), and the failure to go around after the approach became unstable (28% of all hard landing accidents).

Discussion:

During the course of the classification, meteorological phenomena and other factors that lead to a (late) destabilization of the final approach have again been identified as typical precursors of hard landings that led to accidents. Additionally, hard landings often either lead to or have been the result of bounced landings. For this reason in particular the importance of flying stabilized approaches all the way to the landing as well as the recovery of bounced landings continue to be critical areas for crew training activities.

At the same time there are still limitations in the ability of simulators to induce occurrences such as bounced landings at a level of fidelity that is sufficiently high to avoid the danger of "negative training".

Recommendations to Operators:

Bounced landing recovery remains a challenging maneuver for crews and thus continues to be a critical simulator training issue. At the same time limitations of training devices have to be respected. When designing training programs, operators are encouraged to be mindful of the risk of "negative training" (e.g., by asking the trainee to perform a long or bounced landing to practice the recovery thereof). Focus rather has to be on training for the correct landing parameters (e.g., pitch, power, visual picture) on every landing. This is to develop sufficient awareness and motor-skills to always perform the landing the way the airplane manufacturer recommends and to always land at the correct location on the runway, regardless of how favorable or unfavorable the conditions are. Focus also has to be on the fact that the landing is to be rejected should the aforementioned landing parameters not be met.

In addition to the above, and as discussed in other parts of this publication, airlines are recommended to modify their approach procedures to include a call out such as "STABILIZED" or "GO AROUND" at a certain gate to ensure a timely go-around is carried out. Emphasis should also be put on pilots to understand that a destabilization can occur at any altitude and that the set parameters are to be met at all times after the gate and until landing. To provide training that is consistent with this, it is recommended to include training of go-arounds from low altitudes and rejected landings (as well as due to long flares and bounced landings) in the recurrent training program.

Operators are recommended to set procedures that do not require late disconnection of the Auto Pilot. There are events when the crew has no time to enter into the aircraft loop by disconnecting at low altitudes, such as 200 ft, particularly in adverse conditions such as crosswind or gusts, in which case the approach may destabilize on very short final. Pilots need to get a 'feel' for the aircraft.

Introducing scenarios that are common precursors to hard landings in the training environment remains a challenge. In the short term, the challenge could possibly be overcome by workarounds such as introducing very low altitude wind shear on approach. However, operators are encouraged to work with simulator manufacturers to overcome the challenges more systematically in the long term.

Operators are also encouraged to train pilots on landing in real aircraft whenever possible.

Recommendations to Industry:

Aircraft manufacturers are encouraged to provide better guidelines to be used in determining when a hard landing has occurred. These guidelines should be based on measurable factors. As noted above, simulator manufacturers, operators and industry partners are encouraged to work together to develop training devices that are better able to recreate the precursors to a hard landing.

Regulators are encouraged to evaluate landing training requirements.

In-flight Decision Making

Background:

With fuel prices increasing, financial pressure to airlines getting higher and airports being more and more congested, the chance of a diversion from the original destination airport will grow.

Discussion:

Many airlines offer strategies to their pilots for decision making in abnormal conditions and failure cases. Often, they are sound concepts based on TEM models and they are demonstrated to crews on a regular basis.

However, very few strategies can be found for normal operations in terms of giving the crews guidelines for desirable conditions and triggers for diversion enroute and at destination.

Standard alternate airports are mainly based on official weather minima. In the case of a real diversion, crews may find themselves in conditions that are the same or even worse than at the original destination, now however with considerably less fuel.

The difference between a legal alternate and a sound and valid new option is often not considered by crews when diverting, nor is this trained.

This may end up in a cul-de-sac situation with minimum fuel or, in the worst case, in a hopeless situation with no fuel.

Often, the airlines` operational control centers do not have all necessary operational information about possible diversion alternates available.

Recommendation to Industry:

Develop and maintain databases for hazards enroute or at specific airports and make them available to airline crews and operational control centers.

Recommendation to Operators:

Create and train a model for inflight decision making in normal daily operations.

These models should be a solid concept that allows crews to have a stringent and timely strategy for diversion airport assessment.

As a minimum, a diversion airport should always have adequate weather conditions which may be different from legal minima. Operational conditions should be such that the traffic situation and system outages presentno constraint to a safe landing. The airport layout should allow for more than one possibility to land (e.g., at least a parallel taxiway).

Enable operational control centers or dispatch to have access to enroute alternate airport databases and means to transfer this information to flight crews enroute.

FINAL STATEMENTS – Recommendation to Operators

With accident rates at near historic lows, questions now need to be asked about how safety can be improved with such a limited number of accidents. The answer is common industry knowledge: focus on incidents.

The ACTF recommends that operators continue to develop their use of statistical analysis of incident data to identify areas of increased risk in their operation and take appropriate action to mitigate those risks. One such method is through the use of predictive analytics, this uses statistical methods to evaluate incidents and develop transfer probabilities of the incidents becoming accidents. Using a properly developed model will allow the operators to predict the outcomes of changes to their operations in mitigating risk in one area without increasing risk in another.

A report introducing the concept of predictive analytics for the aviation industry has been prepared for this year's Safety Report by the Technical University of Munich in collaboration with Lufthansa and is presented in the next chapter.

Section 9

Predictive Analysis

BACKGROUND

Today, airlines are required by law to implement a safety management system for their flight operation as described by the ICAO document, Safety Management Manual (ICAO DOC 9589, 3rd Edition, 2013). As part of the safety management system, each airline is required to commit itself to a so-called Acceptable Level of Safety Performance (ALoSP). The Safety Management Manual defines the ALoSP as follows:

"The minimum level of safety performance […] of a service provider, as defined in its safety management system expressed in terms of safety performance targets and safety performance indicators."

This definition implies that the ALoSP should be defined in numerical terms (i.e., as a target safety value). Such a numerical value also requires corresponding safety performance indicators (SPI) for measuring the current level of safety. By comparing these SPIs with the ALoSP, it is possible to judge whether the safety objectives have been achieved.

A potential definition of an ALoSP can also be found in Europe's vision for aviation in the year 2050, Flightpath 2050. This report defines a safety target for the whole of Europe in terms of accident rates, specifically, an accident rate of less than one accident for ten million flights. This is equivalent to an accident probability of 10^{-7} per flight, and can serve as a starting point for defining a specific ALoSP for an individual airline.

However, before an airline is able to consider the actions necessary to achieve such a target accident probability, it must be able to measure its safety level.

The most rudimentary method for calculating the current safety level for an individual airline is to compare the number of accidents to the number of total flights. Though simple, this method is also unsuitable in many cases. For example, if an airline has no accidents during its entire history, even if it has had five million flights, one cannot draw the conclusion that the accident rate for the next five million flights will be equal to zero. If an airline uses this method of calculation, it can only be certain that it has met the target safety value after successfully completing ten million flights without having had an accident.

To overcome this problem, it would be natural for an airline to turn to readily available worldwide statistics such as those found in this report. However, since airlines are so different from one another, a safety manager cannot rely on worldwide statistics to draw conclusions about the safety performance of his or her own airline. Accordingly, if an airline wants to manage its safety, it will need specific values that account, for example, for the safety culture, route network, fleet, operations, and training specific to that airline.

PREDICTIVE ANALYSIS

One possible solution to the problems described above is based on predictive analysis. Predictive analysis refers to making a quantitative statement about a future state or condition based on previous experience or knowledge.

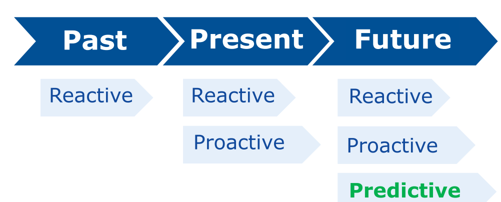


Figure 1: Safety strategies overview

ICAO also recommends predictive analysis, because

"…it deals with hazards when they are at infancy and therefore have no opportunity to start developing their damaging potential. It also allows a high level of intervention, which is a highly efficient one."

This report proposes one possible implementation of predictive analysis, which focuses on the calculation of the probability that a serious incident will occur within an individual airline. Examples of serious incidents, as defined by ICAO Annex 13, are runway overrun, tailstrike, or hard landing. The next sections describe how an airline can use its individual incident probabilities to calculate the probability of accidents defined in ICAO Annex 13 (hull loss, fatalities, or substantial damages).

Once the framework of predictive analysis has been established, it can also be used to quantify and evaluate the effectiveness of potential risk mitigation measures.

Furthermore, predictive analysis can even be used to identify and quantify factors that contribute to incidents that were previously unknown. To summarize, predictive analysis replaces vague and possibly contradictory statements based on subjective perceptions with numerical values.

THE CHALLENGE OF SMALL NUMBERS

As described above, predictive analysis focuses on quantifying the probabilities of serious incidents for an individual airline. These probabilities are small, yet not equal to zero.

Predictive analysis is based on two steps: Firstly, identifying the factors that contribute to these events and compiling statistics for these factors during normal flight operation. Secondly, using this information to calculate the probability of the incident itself in a statistically valid way. In other words, predictive analysis means looking at statistics and variations that occur during the whole flight operation for a given airline in order to quantify incident probabilities. However, having a numerical value for a certain incident probability is meaningless without accounting for uncertainties.

Incident Metrics

Before incident probabilities can be quantified, incident metrics must to be developed. Incident metrics are used to describe the closeness of a single flight to ending in a specific incident. Put another way, the incident metric describes a safety margin of a particular flight with respect to a particular incident.

Incident metrics have two main characteristics: Firstly, incident metrics can be compared to a limit in order to exactly determine whether an incident has occurred. Secondly, the closer the calculated incident metric is to the limit, the more critical the flight regarding that particular incident. These kinds of incident metrics can be calculated after each flight based on its flight operational data. Examples of such an incident metrics are the stop margin, with respect to a runway overrun, and the tail clearance, with respect to a tailstrike. Figure 2 illustrates the stop margin as a possible incident metric.

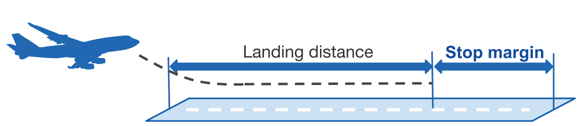


Figure 2: Using the stop margin as a possible incident metric

In Figure 2, the stop margin is the remaining distance between the end of the runway and the stopping position of the aircraft. If an overrun takes place, the stop margin is negative.

Though the types of incidents described in the previous paragraph only lend themselves to a single definition for the incident metric, other incidents can be defined in multiple ways. In this situation, the incident metric should be chosen in a way that results in the most meaningful information with respect to the criticality of the flight.

For example, there are two aircraft flying close to the face of a mountain. Aircraft 1 is flying in a line parallel to the face of the mountain. Aircraft 2 is further away from the face of the mountain, but its flight path intersects with the face of the mountain. Considering the incident type 'controlled flight into terrain', the incident metric should be defined so that it expresses the actual risk that this incident will occur. For example, if the incident metric were based on the distance to the face of the mountain, Aircraft 1 would appear to be at greater risk, though simple logic shows that Aircraft 2 is in much greater danger. For this reason, it would be more meaningful to base the incident metric on the time to impact, which is calculated as the time until impact with the face of the mountain, under the assumption that the aircraft will follow a straight flight path from its current position, at a constant speed.

Turning back to standard flight operation, if an airline tracks the stop margin for a thousand landings, it will see some variation in the measured values, but all values will fall within a completely safe range. This means that while an airline has numerically identified when an incident does or does not occur, it still needs a more precise method for calculating the actual incident probability.

Contributing Factors

The hypothesis in this method is that a given incident can be described as a sum of its constituent parts, so-called contributing factors. When considered individually, an excessive value for a contributing factor is often benign. For example, aircraft landings are often conducted with an approach speed that is slightly higher than normal, with a slightly longer flare than normal, or a little higher tailwind than usual. While any of these deviations itself is harmless, an overrun is usually a result of a combination of a too-high approach speed, a slightly higher tailwind, etc.

Figure 3 illustrates some of the contributing factors for a runway overrun. Every airline that has implemented a flight data monitoring (FDM) program is capable of obtaining information for these factors. In fact, many of the contributing factors are standard measurements, monitored by standard FDM programs, such as the landing weight.

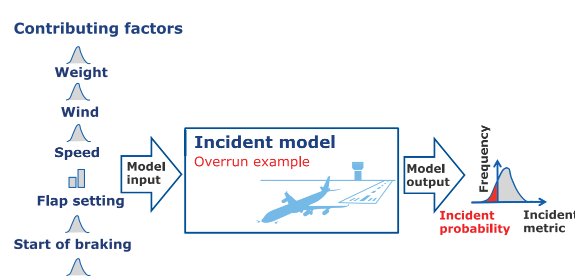


Figure 3: Contributing factors as the input for an incident model

As the distribution for each of the contributing factors in Figure 3 shows, these values vary during flight operation while remaining within a completely safe and overrun-free operation. But if there were a description (model) of the relationships between these contributing factors and how they lead to a runway overrun, these benign variations could be fed into the incident model to calculate the very small probability of the overrun itself occurring.

Incident Models

Incident models include the functional relationships between the contributing factors. Some of these relationships are based on aircraft dynamics, which apply to all airlines, while other relationships result from airline-specific procedures and other information. Once the model has been developed, the airline-specific statistical distributions for each of the contributing factors are propagated through the incident model to obtain a probability for the incident. That resulting probability is no longer equal to zero, even if the airline has never experienced the incident.

For physical relationships, the incident modeling is similar to the development of a simulation model for a flight simulator. The main difference is that a flight simulator propagates single values (e.g., aircraft weight of 234 tons) through a model of aircraft dynamics. In predictive analysis, probability distributions (e.g., landing weight distributed with a mean value of 234 tons and a standard deviation of 4 tons) serve as the input for the model. In addition, the models are tailored to the specific incident. This means that the models include influences having a large impact and do not contain information that is irrelevant to the specific incident. Furthermore, operational dependencies, such as the impact of the runway length on the touchdown behavior of pilots, can be included as well, if they are relevant to the particular incident.

However, unlike aircraft weight or touchdown distance, not all factors entail a continuous distribution of values. Other factors are described by discrete probabilities. These types of factors are also incorporated in the method. Therefore, causal chains are built consisting of a combination of multiple discrete (i.e., yes or no) events to account for factors such as technical failures, human and environmental factors. Since the likelihood of a specific causal chain can be quantified, for example using maintenance data, one can then evaluate how strongly the causal chain impacts the occurrence probabilities of incidents that are related to it.

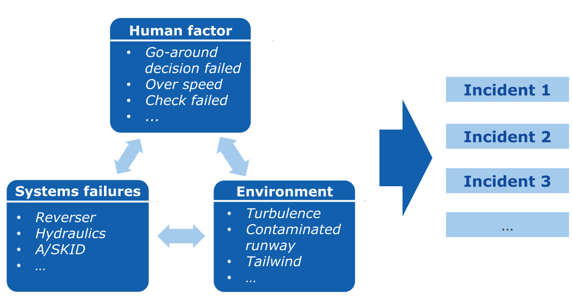


Figure 4: Causal chains

For example, a hydraulic failure can lead to an abnormal flap setting and reduced braking capabilities, which can then potentially contribute to incidents such as tailstrike or runway overrun. This type of analysis can also be compared to the classical fault-tree analysis during aircraft design and certification.

The main benefit of using causal chains is that it is possible to observe the individual contributing elements separately, regardless of whether the element led to an incident when it occurred. This increases the statistical observability of those factors tremendously. For example, as the probability of a thrust reverser failure can be considered to be independent of runway length, touchdown point or tailwind, a valid statistical basis can be generated by recording all reverser failures. The failure of the thrust reverser system might have occurred on a flight to an airport with a long runway or might be compensated by strong headwinds. However, when landing at airports where the runway is short, frequently contaminated, or where landings are often performed with a tailwind, this statistic plays a much more critical role.

Incident Outcome

Once the occurrence probability for a certain incident has been quantified, worldwide accident statistics can be used to estimate the likelihood of certain outcomes that result from the specific type of incident (Figure 5). Examples for typical or possible outcomes would be: fatalities, a hull loss, or the financial consequences from the damage. This report refers to the likelihood of these outcomes as transition probabilities.

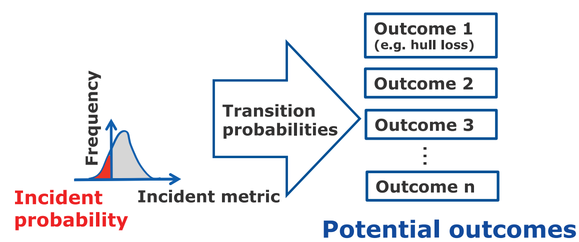


Figure 5: Transition probabilities

TThe transition probability is based on the assumption that once an incident occurs, the outcome is no longer dependent on the specific airline. In other words, these outcomes converge for all airlines, so worldwide statistics can be used in a meaningful manner. For instance, if an aircraft overshoots the runway, the probability that this results in injuries or fatalities is the same for all airlines using comparable equipment.

COLLECTING THE NECESSARY INFORMATION

Making Data Talk: Distribution Fitting

When implementing the measurements of these contributing factors in a FDM program, it is possible to obtain more meaningful information from the very same raw data simply by asking the right questions (i.e., framing the measurements correctly). For example, Figure 6 shows two ways of collecting statistics for the contributing factor wind.

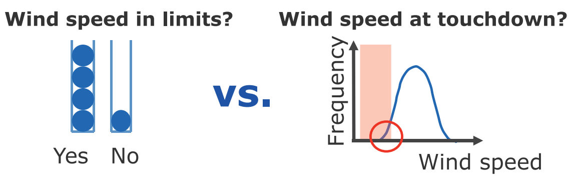


Figure 6: Asking the right questions

The first way is to count all violations of the airline limits during landing regardless of specific wind speeds. The second and better way is to measure the actual wind speeds during touchdown. Here, the airline ends up with a distribution that contains much more information about the contributing factor.

Having obtained meaningful data for the contributing factors, a probabilistic description for the data based on the individual flight operation is needed. These probabilistic descriptions are the input for the incident models. Such a description can be obtained by fitting probability distributions to the data.

The frequently used bell curve (i.e., the Normal or Gaussian distribution) is often unsuitable for describing contributing factor data. This is because the bell curve underestimates the occurrence of values that are far away from the mean value. Recalling the overrun example: the combination of long landings, late application of brakes, high tailwind component may lead to an overrun. In this case, the focus is not on the hump of the curve, but rather at the extreme values at the tail ends. For this reason, it must be ensured that the probabilistic description of each factor (i.e., the fitted probability distribution) fits the collected data particularly closely at the tail ends of the distributions. For example, in Figure 7, the Gaussian distribution does not provide a particularly close fit of the data.

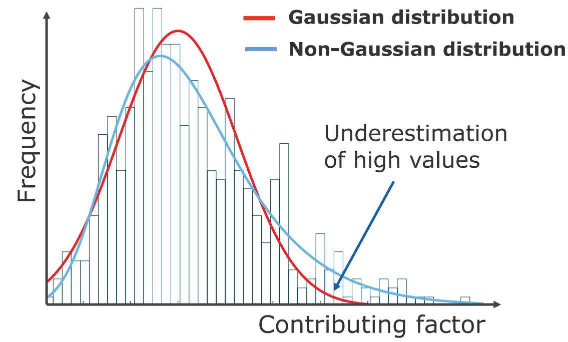


Figure 7 – Distribution fitting

Specifically, the curve fits the extreme values at the tail end poorly. This means that if the Gaussian distribution is selected, the estimates for the likelihood that these tail values will occur are inaccurate. Propagating these kinds of inaccuracies of the contributing factors through the incident models then leads to inaccurate incident probabilities.

In summary, the challenge in this area is to automatically identify the right distribution type relevant for the incidents to be considered, with the distribution fitting the data well at its tail end.

Parameter Estimation: Revealing Unrecorded Parameters

As already mentioned, many FDM systems are already able to provide data for most of the contributing factors using flight operational data. However, there are also contributing factors that are major physical drivers of incidents but cannot be obtained easily by any current FDM system. Examples of such contributing factors are braking friction coefficients or vertical winds. Parameter estimation techniques can be applied in order to quantify these types of contributing factors.

The methods of parameter estimation can be described as a backward computation technique for obtaining parameters that are not recorded during flight operation. The methods that are applied during parameter estimation to analyze the data gathered in routine flight operation are similar to those typically used for flight-testing. Flight test aircraft are usually fitted with elaborate instrumentation for observing these types of parameters during the flight itself. Furthermore, the pilot deliberately flies excitation maneuvers to maximize the observability of the desired parameters. It is understood that neither specific flight test instrumentation will be on board a normal aircraft, nor will the pilot fly active identification maneuvers. The scientific challenge is to observe the relevant contributing factors without the availability of dedicated sensors and excitation maneuvers.

After applying a tailored parameter estimation technique to the available flight data, the unrecorded parameters are obtained as if they had been recorded all along during the flight. One example that illustrates parameter estimation is the wind speed components. Figure 8 shows the plot of estimated wind speed components during the approach of a particular flight.

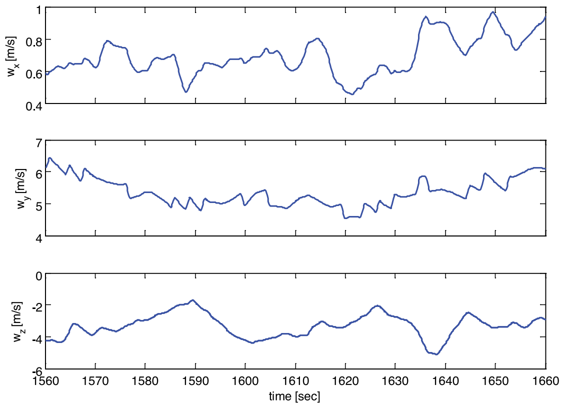


Figure 8: Estimation of wind speeds

The estimated vertical speed (z-axis) component is *not* recorded, but by implementing estimation methods an airline can reveal information that can be used in terms of flight safety

SENSITIVITIES AND CHANGE MANAGEMENT

AAt this point, an airline is able to identify the most likely incident for its flight operation. The following section presents how predictive analysis enables airlines to identify the driving factors behind that incident and to assess potential measures to reduce its incident probabilities.

Currently, airlines already have a solid intuitive grasp on the main incident drivers, but are unable to quantify them. In many cases, the airlines are forced to rely on expert judgments, which are subjective and can therefore vary. The benefit of the model-based predictive analysis described in this report is that it enables airlines to quantify the influence (i.e., the sensitivity) of each contributing factor on the incident probability. The greater the sensitivity value of a contributing factor, the higher its effect on the occurrence probabilities.

Using the sensitivity factors, an airline is able to quantify and prioritize the main incident drivers. Furthermore, contributing factors can be categorized according to their postholder, or tagged with other information beneficial for an airline. Figure 9 shows examples of sensitivities for contributing factors for runway overrun, such as start of braking, air pressure and their allocation to the postholders, training (TRA), environment (ENV), and flight operations (FOPS).

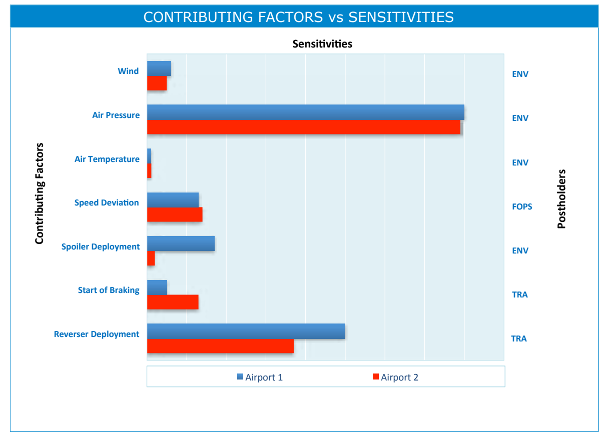


Figure 9: Sensitivity example

Some contributing factors are beyond the airline's scope of influence such as, environmental factors like the temperature at a given airport, or the design of the aircraft. However, an airline is still in control of many other factors.

Predictive analysis also enables airlines to assess the effectiveness of certain mitigation actions in order to increase their safety level even before the measures are implemented (change management). Instead of inputting distributions derived from actual flight operations for the contributing factors, new hypothetical distributions for some of the contributing factors are created to reflect the proposed mitigation actions; these are input into the incident models in order to compare the improvement achieved by the measure with the status quo.

For example, how would training landing technique, which would potentially result in fewer deviations from the desired touchdown point, affect the incident probability? Another possible assessment would be whether the landing weight or the tailwind component should be limited. This includes the identification of a limit that is still in line with the airline's ALoSP.

A particular advantage of the proposed method reflects the fact that since incident models are linked with each other, a change in a contributing factor might also influence the occurrence probability of one or more other incidents. For example, in order to reduce the risk of a runway overrun, a potential mitigation measure could be to decrease the average approach speed by several knots. By inputting the proposed changes into the incident model, the airline would observe the desired decrease of the runway overrun probability, but at the expense of a simultaneous increase in the probabilities of tailstrike and hard landing. In addition to finding that the tailstrike and hard landing probabilities increase, which could have also been found through an assessment by an expert, the airline now receives specific valid numbers for the change in occurrence probabilities (i.e., quantifies the changes in their probabilities).

Of course, not all incidents are equally suitable for modelling. However, incidents driven by physics lend themselves particularly well to physical modeling. For example, incidents during take-off and landing or loss of control in-flight. So, even if not all types of incidents can be modeled for the time being, the most critical incidents for the flight safety record of an airline are addressed by this method.

IDENTIFYING THE UNKNOWN

So far, contributing factors have been combined into models to predict incident probabilities. The next natural step would then be to look for and quantify previously unknown contributing factors, as well as their impact on incidents.

The abovementioned incident metrics, which describe how close a single flight is to an incident, are used in order to find these factors. In this particular area the goal becomes to investigate which unknown factors, and particularly which combinations of factors, lead to such close calls, using data obtained from FDM systems or by any other method introduced previously in this article. In order to succeed, the underlying structure of dependencies are required.

In general, a typical measure for quantifying the dependence between two factors is the correlation coefficient, which is already used in many FDM tools. However, these correlation coefficients are only capable of correctly capturing a certain kind of dependence between two factors, the so-called linear dependence. This means that many other types of dependences cannot be captured at all. However, in aviation, multiple factors influence the incident metric simultaneously. Additionally, different incident metrics can even have an impact on each other.The aim is to describe the dependence structure beyond only linear dependencies between more than two parameters.

To overcome these drawbacks for correlation coefficients, a more advanced statistical tool based on the concept of copulas can be used. Copulas make it possible to simultaneously describe the dependencies between many parameters (Figure 10).

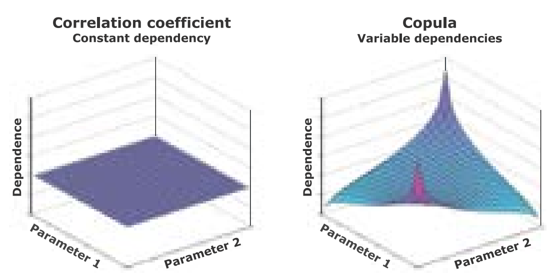


Figure 10: Comparison between correlation coefficients and copula

Figure 10 also shows another major advantage of the copula over the correlation coefficient. While the correlation coefficient assumes a constant dependency between the two parameters throughout the entire domain, the copula is more flexible and is also able to capture local dependencies that are restricted to certain domains.

As described above, flight safety is particularly concerned with extreme values (i.e., the tail end of the distribution). Based on the techniques above, an airline is able to quantify the impact of known contributing factors on incidents. Now, the airline can also relate additional factors from other data sources to the incident type and quantify their dependencies. Examples of such additional factors are duty time and heavy traffic leading to a high ATM workload.

This requires access to information about these parameters, which means that data sources beyond operational flight data are required. Once the connection to the necessary data is established, the statistical method can accommodate them in a flexible manner.

Furthermore, using the incident metrics for several incidents can also help quantify the dependence structure between several incidents. For example, the influence between the incidents runway overrun, tailstrike and hard landing can be quantified. The various incidents do not have to occur; it is sufficient to simply have the computed values of their incident metrics.

Figure 11 summarizes the differences between the physical (model based) approach and the statistical approach. The physical approach uses incident models, including the functional relationships between contributing factors, to calculate incident probabilities. In contrast, the statistical approach applies copulas to identify and quantify other factors that could potentially contribute to incidents.

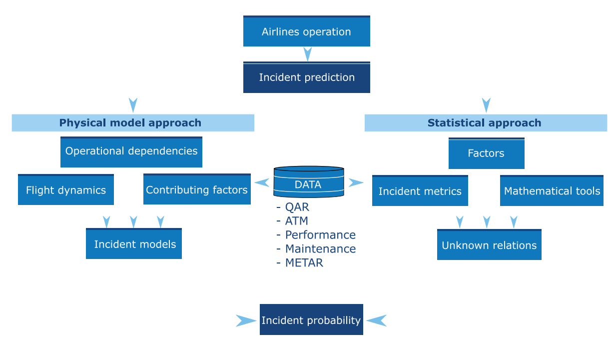


Figure 11: Overview of predictive analysis techniques

FUTURE WORK

Looking towards the future, there is potential to compare planned and actual performance (Figure 12).

Figure 12: Comparison between planned performance and actual performance

This potential can be illustrated by means of take-offs. Currently, the take-off performance calculation is usually discarded after a flawless flight. By implementing a continuous comparison between planned and actual take-off distances, an airline would be able to obtain a distribution of the discrepancies between the plan and reality and be able to derive gap factors.

Such gap factors would be able to incorporate an airline's operation into the prediction of the expected take-off distance instead of using the takeoff distance calculated by performance tools that often do not accurately reflect everyday flight operation. Knowing such gap factors would increase a confidence, particularly for airports with peculiarities such as short runways, sloped runways, or when safety margins are low due to other factors (e.g., hot-and-high airports).

Of course, a continuous comparison is not limited to take-offs; the same holds for landings, for fuel consumption, or for anything else in which reality can be compared to pre-flight planning.

WHY DATA OPENS DOORS

In conclusion, many airlines already possess the means for implementing predictive analysis, since it is primarily based on flight data recorded during routine operations. It can be used to quantify current incident probabilities as well as the sensitivities of the contributing factors with respect to the incident probabilities. In addition, dependencies and unforeseen contributions of various factors can be detected using advanced statistical methods, such as copulas.

The predictive analysis being presented is based on joint efforts between Deutsche Lufthansa AG and the Institute of Flight System Dynamics at Technische Universität München (TUM). Specifically, these achievements are also a result of Lufthansa's willingness to exchange operational information.

IATA's recently established Global Aviation Data Management program and the vision of the Technische Universität München could complement each other very well. Therefore, IATA and the TUM are evaluating possible opportunities for further cooperation on predictive analysis to provide an additional tool for the aviation industry to proactively identify safety risks.

The judgment of experts, pilots and other aviation professionals will always remain the primary source for reviewing flight safety. However, adding statistically valid numbers gained from the recorded truth of the airline's data and based on undisputable foundations such as the laws of physics will add insight, credibility and objectivity.

Predictive analysis will no doubt be an integral part of the toolbox that will help keep the skies of tomorrow safe!

Authors: Ludwig Drees, Javensius Sembiring, Lukas Höhndorf, Chong Wang, and Florian Holzapfel

Institute of Flight System Dynamics

Technische Universität München

"The objective of the GSIE is to identify information that can be exchanged between the parties to enhance risk reduction activities in the area of aviation safety."

Section 10

GSIE Harmonized Accident Rate

In the spirit of promoting aviation safety, the Department of Transportation of the United States, the Commission of the European Union, the International Air Transport Association (IATA) and the International Civil Aviation Organization (ICAO) signed a Memorandum of Understanding (MoU) on a Global Safety Information Exchange (GSIE) on 28 September 2010 during the 37th Session of the ICAO Assembly. The objective of the GSIE is to identify information that can be exchanged between the parties to enhance risk reduction activities in the area of aviation safety.

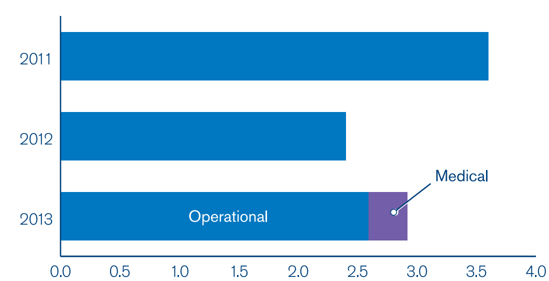
The GSIE developed a harmonized accident rate beginning in 2011. This was accomplished through close co-operation between ICAO and IATA to align accident definitions, criteria and analysis methods used to calculate the harmonized rate, which is considered a key safety indicator for commercial aviation operations worldwide. The joint analysis includes accidents meeting the ICAO Annex 13 criteria for all typical commercial airline operations for scheduled and non-scheduled flights.

For 2013, ICAO and IATA have further harmonized the accident analysis process and have developed a common list of flight phases and accident categories to facilitate the sharing and integration of safety data between the two organizations.

ANALYSIS OF HARMONIZED ACCIDENTS

A total of 103 accidents were considered as part of the harmonized accident criteria. These include scheduled and non-scheduled commercial operations, including ferry flights, for aircraft with a maximum certificated take-off weight above 5700kg. The GSIE harmonized accident rate for the period of 2011 (the first year the rate was calculated) to 2013 is shown below. New for 2013 is a breakdown of the rate in terms of the operational safety component, covering accidents involving damage to aircraft and the medical/injury component pertaining to accidents with serious or fatal injuries to persons, but little or no damage to the aircraft itself.

GSIE HARMONIZED ACCIDENT RATE



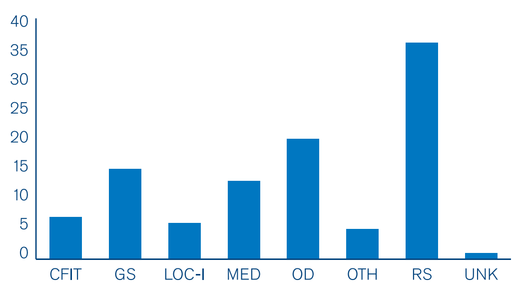
Definitions and Methods

In order to build upon the harmonized accident rate presented in the last two safety reports, ICAO and IATA worked closely to develop a common taxonomy that would allow for a seamless integration of accident data between the two organizations. A detailed explanation of the harmonized accident categories and how they relate to the Commercial Aviation Safety Team/ICAO Common Taxonomy Team (CICTT) occurrence categories can be found in Appendix 3.

A common list of flight phases between ICAO and IATA was developed using the CICTT Phases of Flight standard.

Harmonized Accident Categories

The fundamental differences in the approaches of the ICAO (CICTT Occurrence Categories) and IATA (Flight-crew Centric Threat and Error Management Model) classification systems required a completely new categorization of accidents using the harmonized criteria. The breakdown of accidents by harmonized category can be seen in the figure below



Number of Accidents, 2013

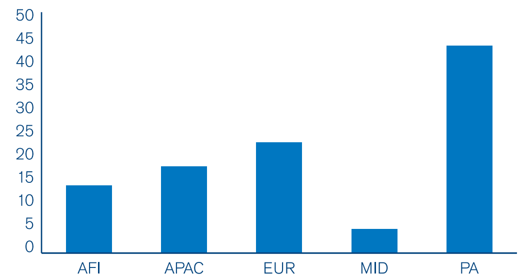
Accident Categories

Controlled Flight into Terrain (CFIT)
Loss of Control in-flight (LOC-I)
Runway Safety (RS)
Ground Safety (GS)
Operational Damage (OD)
Injuries to and/or Incapacitation of Persons (MED)
Other (OTH)
Unknown (UNK)

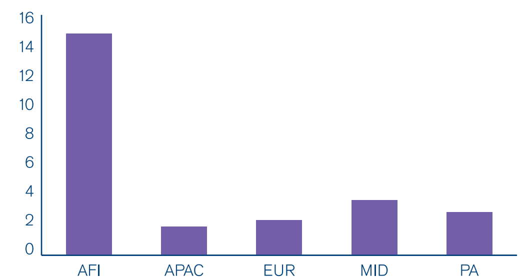
Full details of categories at the back of this section

Accident by Region

A harmonized regional analysis is provided using the ICAO Regional Aviation Safety Group regions. The number of accidents and harmonized accident rate in 2013 by region are shown in the figures below:



Number of Accidents, 2013

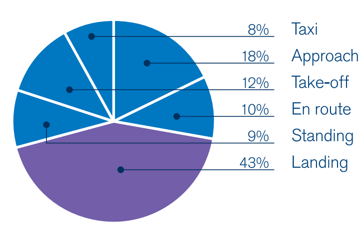


Accident Rate, 2013

Full breakdown of regions at the back of this section

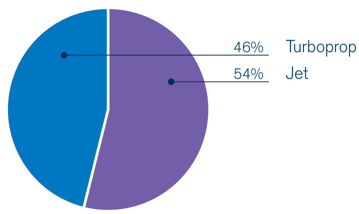
Phase of Flight

As mentioned earlier, the CICTT Phases of Flight are used for ICAO/IATA harmonized safety analysis. When evaluating the 103 accidents in 2013 by phase of flight, the following distribution is obtained:



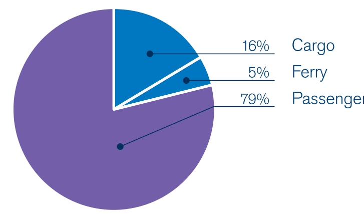
Aircraft Propulsion

The type of propulsion was also considered as part of the analysis. While 46% of accidents occurred to turboprop aircraft in 2013, they represent a much smaller percentage of the global commercial fleet than jet aircraft do.



Type of Service

The breakdown of accidents with respect to the type of service is shown below. The majority (79%) of 2013 accidents involved passenger flights, while cargo represented 16% of the harmonized accidents reviewed.



Future Development

Both ICAO and IATA endeavor to continue to work closely together and, through their respective expert groups, provide greater alignment in their analysis methods and metrics for the future. This ongoing work will be shared with all GSIE participants, States, international organizations and all safety stakeholders in the interest of promoting common, harmonized safety reporting at the global level.

GSIE HARMONIZED ACCIDENT CATEGORIES

Category	Description
Controlled Flight into Terrain (CFIT)	Includes all instances where the aircraft was flown into terrain in a controlled manner, regardless of the crew's situational awareness. Does not include undershoots, overshoots or collisions with obstacles on take-off and landing which are included in Runway Safety
Loss of Control In-flight (LOC-I)	Loss of control in-flight that is not recoverable.
Runway Safety (RS)	Includes runway excursions and incursions, undershoot/overshoot, tailstrike and hard landing events.
Ground Safety (GS)	Includes ramp safety, ground collisions, all ground servicing, pre-flight, engine start/departure and arrival events. Taxi and towing events are also included.
Operational Damage (OD)	Damage sustained by the aircraft while operating under its own power. This includes in-flight damage, foreign object debris (FOD) and all system or component failures.
Injuries to and/or Incapacitation of Persons (MED)	All injuries or incapacitations sustained by anyone in direct contact with the aircraft. Includes turbulence-related injuries, injuries to ground staff coming into contact with the aircraft and on-board incapacitations and fatalities not related to unlawful external interference.
Other (OTH)	Any event that does not fit into the categories listed above.
Unknown (UNK)	Any event whereby the exact cause cannot be reasonably determined through information or inference, or when there are insufficient facts to make a conclusive decision regarding classification.

Category	CICTT Occurrence Catogies	IATA Classification End States
Controlled Flight into Terrain (CFIT)	CFIT, CTOL	CFIT
Loss of Control In-flight (LOC-I)	LOC-I	Loss of Control In-flight
Runway Safety (RS)	RE, RI, ARC, USOS	Runway Excursion, Runway Collision, Tailstrike, Hard Landing, Undershoot
Ground Safety (GS)	G-COL, RAMP, LOC-G	Ground Damage
Operational Damage (OD)	SCF-NP, SCF-PP	In-flight Damage
Injuries to and/or Incapacitation of Persons (MED)	CABIN, MED, TURB	None (excluded in IATA Safety Report)
Other (OTH)	All other CICTT Occurrence Categories	All other IATA End States
Unknown (UNK)	UNK	Insufficient Information

RASG Region	List of Countries
Africa (AFI)	Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Côte d'Ívoire, Democratic Republic of the Congo, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Île De La Réunion (Fr.), Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mayotte (Fr.), Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, South Sudan, Swaziland, Togo, Uganda, United Republic of Tanzania, Zambia, Zimbabwe
Asia Pacific (APAC)	Afghanistan, American Samoa (U.S.A.), Australia, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, Cook Islands, Democratic People's Republic of Korea, Democratic Republic of Timor-Leste, Federated States of Micronesia, Fiji, French Polynesia (Fr.), Guam (U.S.A.), India, Indonesia, Japan, Kiribati, Lao People's Democratic Republic, Malaysia, Maldives, Marshall Islands, Mongolia, Myanmar, Nauru, Nepal, New Caledonia (Fr.), New Zealand, Niue (NZ.), Norfolk Island (Austr.), Northern Mariana Islands (U.S.A.), Pakistan, Palau, Papua New Guinea, Philippines, Republic of Korea, Samoa, Singapore, Solomon Islands, Sri Lanka, Thailand, Tonga, Tuvalu, Vanuatu, Viet Nam, Wallis Is. (Fr.)
Europe (EUR)	Albania, Algeria, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Faroe Islands (Den.), Finland, France, Georgia, Germany, Gibraltar (U.K.), Greece, Greenland (Den.), Hungary, Iceland, Ireland, Israel, Italy, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Luxembourg, Malta, Monaco, Montenegro, Morocco, Netherlands, Norway, Poland, Portugal, Republic of Moldova, Romania, Russian federation, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Tajikistan, The former Yugoslav Republic of Macedonia, Tunisia, turkey, Turkmenistan, Ukraine, United Kingdom, Uzbekistan
Middle East (MID)	Bahrain, Egypt, Iraq, Islamic Republic of Iran, Jordan, Kuwait, Lebanon, Libyan Arab Jamahiriya, Oman, Qatar, Saudi Arabia, Sudan, Syrian Arab Republic, United Arab Emirates, Yemen
Pan-America (PA)	Anguilla (U.K.), Antigua and Barbuda, Argentina, Aruba (Neth.), Bahamas, Barbados, Belize, Bermuda (U.K.), Bolivia, "Bonaire, Saint Eustatius and Saba", Brazil, Canada, Cayman Islands (U.K.), Chile, Colombia, Costa Rica, Cuba, Curaçao, Dominica, Dominican Republic, Ecuador, El Salvador, Falklan Islands (Malvinas), French Guiana (Fr.), Grenada, Guadeloupe (Fr.), Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique (Fr.), Mexico, Montserrat (U.K.), Nicaragua, Panama, Paraguay, Peru, Puerto Rico (U.S.A.), Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Sint Maarten (Dutch part), Suriname, Trinidad and Tobago, Turks and Caicos Islands (U.K.), United States, Uruguay, Venezuela, Virgin Islands (U.S.A.)

Annex 1

Definitions

Accident: an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, in which:

- a person is fatally injured as a result of:
  - (a) being in the aircraft;
  - (b) direct contact with any part of the aircraft, including parts which have become detached from the aircraft; or
  - (c) direct exposure to jet blast

except when the injuries are from natural causes, self-inflicted or inflicted by other persons, or when the injuries are to stowaways hiding outside the areas normally available to the passengers and crew;

- the aircraft sustains damage or structural failure which:
  - (a) adversely affects the structural strength, performance or flight characteristics of the aircraft; and
  - (b) would normally require major repair or replacement of the affected component

except for engine failure or damage, when the damage is limited to the engine, its cowlings or accessories; or for damage limited to propellers, wing tips, antennae, tires, brakes, fairings, small dents or puncture holes in the aircraft skin; or the aircraft is still missing or is completely inaccessible.

Notes

1. For statistical uniformity only, an injury resulting in death within thirty days of the date of the accident is classified as a fatal injury by ICAO.

2. An aircraft is considered to be missing when the official search has been terminated and the wreckage has not been located.

For purposes of this Safety Report, only operational accidents are classified.

The following types of operations are excluded:

- Private aviation
- Business aviation
- Illegal flights (e.g., cargo flights without an airway bill, fire arms or narcotics trafficking)
- Humanitarian relief
- Crop dusting/agricultural flights
- Security-related events (e.g., hijackings)
- Experimental/Test flight

Accident classification: the process by which actions, omissions, events, conditions, or a combination thereof, which led to the accident are identified and categorized.

Aircraft: the involved aircraft, used interchangeably with airplane(s).

Air Traffic Service unit: as defined in applicable ATS, Search and Rescue and overflight regulations.

Cabin Safety-related Event: accident involving cabin operations issues, such as a passenger evacuation, an onboard fire, a decompression or a ditching, which requires actions by the operating cabin crew.

Captain: the involved pilot responsible for operation and safety of the aircraft during flight time.

Commander: the involved pilot, in an augmented crew, responsible for operation and safety of the aircraft during flight time.

Crewmember: anyone on board a flight who has duties connected with the sector of the flight during which the accident happened. It excludes positioning or relief crew, security staff, etc. (see definition of "Passenger" below).

Eastern-built Jet aircraft: commercial jet transport aircraft designed in CIS countries or the People's Republic of China.

Eastern-built Turboprop aircraft: commercial turboprop transport aircraft designed in CIS countries or the People's Republic of China.

Evacuation: Passengers and/or crew evacuate aircraft via escape slides, doors, emergency exits, or gaps in fuselage, usually initiated in life threatening or catastrophic events.

Fatal accident: an accident where at least one passenger or crewmember is killed or later dies of their injuries as a result of an operational accident.

Events such as slips and falls, food poisoning, turbulence or accidents involving on board equipment, which may involve fatalities but where the aircraft sustains minor or no damage, are excluded.

Fatality: a passenger or crewmember who is killed or later dies of their injuries resulting from an operational accident. Injured persons who die more than 30 days after the accident are excluded.

Hazard: condition, object or activity with the potential of causing injuries to personnel, damage to equipment or structures, loss of material, or reduction of ability to perform a prescribed function.

Hull loss: an accident in which the aircraft is destroyed or substantially damaged and is not subsequently repaired for whatever reason including a financial decision of the owner.

IATA accident classification system: refer to Annexes 2 and 3 of this report.

IATA regions: IATA determines the accident region based on the operator's home country as specified in the operator's Air Operator Certificate (AOC).

For example, if a Canadian-registered operator has an accident in Europe, this accident is counted as a "North American" accident.

For a complete list of countries assigned per region, please consult the following table:

IATA REGIONS

Region	Country
AFI	Angola
	Benin
	Botswana
	Burkina Faso
	Burundi
	Cameroon
	Cape Verde
	Central African Republic
	Chad
	Comoros
	Congo, Democratic Republic of
	Congo, Republic of
	Côte d'Ivoire
	Djibouti
	Equatorial Guinea
	Eritrea
	Ethiopia
	Gabon
	Gambia
	Ghana
	Guinea
	Guinea-Bissau
	Kenya
	Lesotho
	Liberia
	Madagascar
	Malawi
	Mali
	Mauritania
	Mauritius
	Mozambique
	Namibia
	Niger
	Nigeria
	Rwanda
	São Tomé and Príncipe
	Senegal
	Seychelles
	Sierra Leone
	Somalia
	South Africa

Region	Country
	South Sudan
	Swaziland
	Tanzania
	Togo
	Uganda
	Zambia
	Zimbabwe
ASPAC	Australia[1]
	Bangladesh
	Bhutan
	Brunei Darussalam
	Burma
	Cambodia
	East Timor
	Fiji Islands
	India
	Indonesia
	Japan
	Kiribati
	Laos
	Malaysia
	Maldives
	Marshall Islands
	Micronesia
	Nauru
	Nepal
	New Zealand[2]
	Pakistan
	Palau
	Papua New Guinea
	Philippines
	Samoa
	Singapore
	Solomon Islands
	South Korea
	Sri Lanka
	Thailand
	Tonga
	Tuvalu, Ellice Islands
	Vanuatu
	Vietnam

Region	Country
CIS	Armenia
	Azerbaijan
	Belarus
	Georgia
	Kazakhstan
	Kyrgyzstan
	Moldova
	Russia
	Tajikistan
	Turkmenistan
	Ukraine
	Uzbekistan
EUR	Albania
	Andorra
	Austria
	Belgium
	Bosnia and Herzegovina
	Bulgaria
	Croatia
	Cyprus
	Czech Republic
	Denmark[3]
	Estonia
	Finland
	France[4]
	Germany
	Greece
	Hungary
	Iceland
	Ireland
	Italy
	Israel
	Kosovo
	Latvia
	Liechtenstein
	Lithuania
	Luxembourg
	Macedonia
	Malta
	Monaco
	Montenegro
	Netherlands[5]

Region	Country
	Norway
	Poland
	Portugal
	Romania
	San Marino
	Serbia
	Slovakia
	Slovenia
	Spain
	Sweden
	Switzerland
	Turkey
	United Kingdom[6]
	Vatican City
LATAM	Antigua and Barbuda
	Argentina
	Bahamas
	Barbados
	Belize
	Bolivia
	Brazil
	Chile
	Colombia
	Costa Rica
	Cuba
	Dominica
	Dominican Republic
	Ecuador
	El Salvador
	Grenada
	Guatemala
	Guyana
	Haiti
	Honduras
	Jamaica
	Mexico
	Nicaragua
	Panama
	Paraguay
	Peru
	Saint Kitts and Nevis
	Saint Lucia

Region	Country
	Saint Vincent and the Grenadines
	Suriname
	Trinidad and Tobago
	Uruguay
	Venezuela
MENA	Afghanistan
	Algeria
	Bahrain
	Egypt
	Iran
	Iraq
	Jordan
	Kuwait
	Lebanon
	Libya
	Morocco
	Oman
	Qatar
	Saudi Arabia
	Sudan
	Syria
	Tunisia
	United Arab Emirates
	Yemen
NAM	Canada
	United States of America[7]
NASIA	China[8]
	Mongolia
	North Korea

[1]Australia includes:

Christmas Island
Cocos (Keeling) Islands
Norfolk Island
Ashmore and Cartier Islands
Coral Sea Islands
Heard Island and McDonald Islands

[2]New Zealand includes:

Cook Islands
Niue
Tokelau

[3]Denmark includes:

Faroe Islands
Greenland

[4]France includes:

French Polynesia
New Caledonia
Saint-Barthélemy
Saint Martin
Saint Pierre and Miquelon
Wallis and Futuna
French Southern and Antarctic Lands

[5]Netherlands include:

Aruba

[6]United Kingdom includes:

England
Scotland
Wales
Northern Ireland
Akrotiri and Dhekelia
Anguilla
Bermuda
British Indian Ocean Territory
British Virgin Islands
Cayman Islands
Falkland Islands
Gibraltar
Montserrat
Pitcairn Islands
Saint Helena
South Georgia and the South Sandwich Islands
Turks and Caicos Islands
British Antarctic Territory
Guernsey
Isle of Man
Jersey

[7]United States of America include:

American Samoa
Guam
Northern Mariana Islands
Puerto Rico
United States Virgin Islands

[8]China includes:

Hong Kong
Macau
Chinese Taipei

Incident: an occurrence, other than an accident, associated with the operation of an aircraft which affects or could affect the safety of operation.

In-flight Security Personnel: an individual who is trained, authorized and armed by the state and is carried on board an aircraft and whose intention is to prevent acts of unlawful interference.

Investigation: a process conducted for the purpose of accident prevention, which includes the gathering and analysis of information, the drawing of conclusions, including the determination of causes and, when appropriate, the making of safety recommendations.

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

Involved: directly concerned, or designated to be concerned, with an accident or incident.

Level of safety: how far safety is to be pursued in a given context, assessed with reference to an acceptable risk, based on the current values of society.

Major repair: a repair which, if improperly done, might appreciably affect mass, balance, structural strength, performance, powerplant operation, flight characteristics, or other qualities affecting airworthiness.

Non-operational accident: this definition includes acts of deliberate violence (sabotage, war, etc.), and accidents that occur during crew training, demonstration and test flights. Sabotage is believed to be a matter of security rather than flight safety, and crew training, demonstration and test flying are considered to involve special risks inherent to these types of operations.

Also included in this category are:

- Non-airline operated aircraft (e.g., military or government operated, survey, aerial work or parachuting flights);
- Accidents where there has been no intention of flight

Occurrence: any unusual or abnormal event involving an aircraft, including but not limited to, an incident.

Operational accident: an accident which is believed to represent the risks of normal commercial operation, generally accidents which occur during normal revenue operations or positioning flights.

Operator: a person, organization or enterprise engaged in, or offering to engage in, aircraft operations.

Passenger: anyone on board a flight who, as far as may be determined, is not a crewmember. Apart from normal revenue passengers this includes off-duty staff members, positioning and relief flight crew members, etc., who have no duties connected with the sector of the flight during which the accident happened. Security ersonnel are included as passengers as their duties are not concerned with the operation of the flight.

Person: any involved individual, including airport and ATS personnel.

Phase of flight: the phase of flight definitions applied by IATA were developed by the Air Transport Association (ATA). They are presented in the following table:

PHASE OF FLIGHT DEFINITIONS

Flight Planning (FLP) This phase begins when the flight crew initiates the use of flight planning information facilities and becomes dedicated to a flight based upon a route and an airplane; it ends when the crew arrives at the aircraft for the purpose of the planned flight or the crew initiates a "Flight Close" phase.

Pre-flight (PRF) This phase begins with the arrival of the flight crew at an aircraft for the purpose of flight; it ends when a dedication is made to depart the parking position and/or start the engine(s). It may also end by the crew initiating a "Post-flight" phase.

Note: The Pre-flight phase assumes the aircraft is sitting at the point at which the aircraft will be loaded or boarded, with the primary engine(s) not operating. If boarding occurs in this phase, it is done without any engine(s) operating. Boarding with any engine(s) operating is covered under Engine Start/Depart.

Engine Start/Depart (ESD) This phase begins when the flight crew take action to have the aircraft moved from the parked position and/or take switch action to energize the engine(s); it ends when the aircraft begins to move forward under its own power or the crew initiates an "Arrival/Engine Shutdown" phase.

Note: The Engine Start/Depart phase includes: the aircraft engine(s) start-up whether assisted or not and whether the aircraft is stationary with more than one engine shutdown prior to Taxi-out, (i.e., boarding of persons or baggage with engines running). It includes all actions of power back for the purpose of positioning the aircraft for Taxi-out.

Taxi-out (TXO) This phase begins when the crew moves the aircraft forward under its own power; it ends when thrust is increased for the purpose of Take-off or the crew initiates a "Taxi-in" phase.

Note: This phase includes taxi from the point of moving under its own power, up to and including entering the runway and reaching the Take-off position.

Take-off (TOF) This phase begins when the crew increases the thrust for the purpose of lift-off; it ends when an Initial Climb is established or the crew initiates a "Rejected Take-off" phase.

Rejected Take-off (RTO) This phase begins when the crew reduces thrust for the purpose of stopping the aircraft prior to the end of the Take-off phase; it ends when the aircraft is taxied off the runway for a "Taxi-in" phase or when the aircraft is stopped and engines shutdown.

Initial Climb (ICL) This phase begins at 35 ft above the runway elevation; it ends after the speed and configuration are established at a defined maneuvering altitude or to continue the climb for the purpose of cruise. It may also end by the crew initiating an "Approach" phase.

Note: Maneuvering altitude is based upon such an altitude to safely maneuver the aircraft after an engine failure occurs, or pre defined as an obstacle clearance altitude. Initial Climb includes such procedures applied to meet the requirements of noise abatement climb, or best angle/rate of climb.

En Route Climb (ECL) This phase begins when the crew establishes the aircraft at a defined speed and configuration enabling the aircraft to increase altitude for the purpose of cruising; it ends with the aircraft established at a predetermined constant initial cruise altitude at a defined speed or by the crew initiating a "Descent" phase.

Cruise (CRZ) The cruise phase begins when the crew establishes the aircraft at a defined speed and predetermined constant initial cruise altitude and proceeds in the direction of a destination; it ends with the beginning of Descent for the purpose of an approach or by the crew initiating an "En Route Climb" phase.

Descent (DST) This phase begins when the crew departs the cruise altitude for the purpose of an approach at a particular destination; it ends when the crew initiates changes in aircraft configuration and/or speeds to facilitate a landing on a particular runway. It may also end by the crew initiating an "En Route Climb" or "Cruise" phase.

Approach (APR) This phase begins when the crew initiates changes in aircraft configuration and /or speeds enabling the aircraft to maneuver for the purpose of landing on a particular runway; it ends when the aircraft is in the landing configuration and the crew is dedicated to land on a specific runway. It may also end by the crew initiating an "Initial Climb" or "Go-around" phase.

Go-around (GOA) This phase begins when the crew aborts the descent to the planned landing runway during the Approach phase, it ends after speed and configuration are established at a defined maneuvering altitude or to continue the climb for the purpose of cruise (same as end of "Initial Climb").

Landing (LND) This phase begins when the aircraft is in the landing configuration and the crew is dedicated to touch down on a specific runway; it ends when the speed permits the aircraft to be maneuvered by means of taxiing for the purpose of arriving at a parking area. It may also end by the crew initiating a "Go-around" phase.

Taxi-in (TXI) This phase begins when the crew begins to maneuver the aircraft under its own power to an arrival area for the purpose of parking; it ends when the aircraft ceases moving under its own power with a commitment to shut down the engine(s). It may also end by the crew initiating a "Taxi-out" phase.

Arrival/Engine Shutdown (AES) This phase begins when the crew ceases to move the aircraft under its own power and a commitment is made to shutdown the engine(s); it ends with a dedication to shutting down ancillary systems for the purpose of securing the aircraft. It may also end by the crew initiating an "Engine Start/Depart" phase.

Note: The Arrival/Engine Shutdown phase includes actions required during a time when the aircraft is stationary with one or more engines operating while ground servicing may be taking place, (i.e., deplaning persons or baggage with engine(s) running, and or refueling with engine(s) running).

Post-flight (PSF) This phase begins when the crew commences the shutdown of ancillary systems of the aircraft for the purpose of leaving the flight deck; it ends when the cockpit and cabin crew leaves the aircraft. It may also end by the crew initiating a "Pre-flight" phase.

Flight Close (FLC) This phase begins when the crew initiates a message to the flight-following authorities that the aircraft is secure, and the crew is finished with the duties of the past flight; it ends when the crew has completed these duties or begins to plan for another flight by initiating a "Flight Planning" phase.

Ground Servicing (GDS) This phase begins when the aircraft is stopped and available to be safely approached by ground personnel for the purpose of securing the aircraft and performing the duties applicable to the arrival of the aircraft, aircraft maintenance, etc.; it ends with completion of the duties applicable to the departure of the aircraft or when the aircraft is no longer safe to approach for the purpose of ground servicing. (e.g., prior to crew initiating the "Taxi-out" phase.)

Note: This phase was identified by the need for information that may not directly require the input of cockpit or cabin crew. It is acknowledged as an entity to allow placement of the tasks required of personnel assigned to service the aircraft.

Products: liabilities, in terms of accident costs, which fall on parties other than the involved operator.

Rapid Deplaning: passengers and/or crew rapidly exit aircraft via boarding doors and via jet bridge or stairs, for precautionary measures.

Risk: the assessment, expressed in terms of predicted probability and severity, of the consequence(s) of a hazard, taking as reference the worst foreseeable situation.

Safety: the state in which the risk of harm to persons or property damage is reduced to, and maintained at or below, an acceptable level through a continuing process of hazard identification and risk management.

Sector: the operation of an aircraft between take-off at one location and landing at another (other than a diversion).

Serious Injury: an injury which is sustained by a person in an accident and which:

- Requires hospitalization for more than 48 hours, commencing within seven days from the date the injury was received; or
- Results in a fracture of any bone (except simple fractures of fingers, toes or nose); or
- Involves lacerations which cause severe haemorrhage, or nerve, muscle or tendon damage;
- Involves injury to any internal organ; or
- Involves second or third-degree burns, or any burns affecting more than five percent of the surface of the body; or
- Involves verified exposure to infectious substances or injurious radiation

Serious Incident: an incident involving circumstances indicating that an accident nearly occurred (note the difference between an accident and a serious incident lies only in the result).

Sky Marshal: see In-flight Security Personnel.

Substantial Damage: damage or structural failure, which adversely affects the structural strength, performance or flight characteristics of the aircraft, and which would normally require major repair or replacement of the affected component.

Notes:

1. Bent fairing or cowling, dented skin, small punctured holes in the skin or fabric, minor damage to landing gear, wheels, tires, flaps, engine accessories, brakes, or wing tips are not considered "substantial damage" for the purpose of this Safety Report.

2. The ICAO Annex 13 definition is unrelated to cost and includes many incidents in which the financial consequences are minimal.

Unstable Approach: approach where the ACTF has knowledge about vertical, lateral or speed deviations in the portion of the flight close to landing.

Note:

This definition includes the portion immediately prior to touchdown and in this respect the definition might differ from other organizations. However, accident analysis gives evidence that a destabilization just prior to touchdown has contributed to accidents in the past.

Western-built Jet: commercial jet transport aircraft with a maximum certificated take-off mass of more than 15,000 kg, designed in Western Europe, the Americas or Indonesia.

Western-built Turboprop: commercial turboprop transport aircraft with a maximum certificated take-off mass of more than 5,700 kg, designed in Western Europe, the Americas or Indonesia. Single-engine aircraft are excluded.

Annex 2

Accident Classification Taxonomy Flight Crew

1 Latent Conditions

Definition: Conditions present in the system before the accident and triggered by various possible factors.

Latent Conditions (deficiencies in…)	Examples
Design	↗ Design shortcomings ↗ Manufacturing defects
Regulatory Oversight	↗ Deficient regulatory oversight by the State or lack thereof
Management Decisions	↗ Cost cutting ↗ Stringent fuel policy ↗ Outsourcing and other decisions, which can impact operational safety
Safety Management	Absent or deficient: ↗ Safety policy and objectives ↗ Safety risk management (including hazard identification process) ↗ Safety assurance (including Quality Management) ↗ Safety promotion
Change Management	↗ Deficiencies in monitoring change; in addressing operational needs created by, for example, expansion or downsizing ↗ Deficiencies in the evaluation to integrate and/or monitor changes to establish organizational practices or procedures ↗ Consequences of mergers or acquisitions
Selection Systems	↗ Deficient or absent selection standards
Operations Planning and Scheduling	↗ Deficiencies in crew rostering and staffing practices ↗ Issues with flight and duty time limitations ↗ Health and welfare issues

1 Latent Conditions (cont'd)

Technology and Equipment	↗ Available safety equipment not installed (E-GPWS, predictive wind-shear, TCAS/ACAS, etc.)
Flight Operations	See the following breakdown
Flight Operations: Standard Operating Procedures and Checking	↗ Deficient or absent: 1. Standard Operating Procedures (SOPs) 2. operational instructions and/or policies 3. company regulations 4. controls to assess compliance with regulations and SOPs
Flight Operations: Training Systems	↗ Omitted training, language skills deficiencies, qualifications and experience of flight crews, operational needs leading to training reductions, deficiencies in assessment of training or training resources such as manuals or CBT devices
Cabin Operations	See the following breakdown
Cabin Operations: Standard Operating Procedures and Checking	↗ Deficient or absent: 1. Standard Operating Procedures (SOPs) 2. operational instructions and/or policies 3. company regulations 4. controls to assess compliance with regulations and SOPs
Cabin Operations: Training Systems	↗ Omitted training, language skills deficiencies, qualifications and experience of cabin crews, operational needs leading to training reductions, deficiencies in assessment of training or training resources such as manuals or CBT devices
Ground Operations	See the following breakdown
Ground Operations: SOPs and Checking	↗ Deficient or absent: 1. Standard Operating Procedures (SOPs) 2. operational instructions and/or policies 3. company regulations 4. controls to assess compliance with regulations and SOPs
Ground Operations: Training Systems	↗ Omitted training, language skills deficiencies, qualifications and experience of ground crews, operational needs leading to training reductions, deficiencies in assessment of training or training resources such as manuals or CBT devices

1 Latent Conditions (cont'd)

Maintenance Operations	See the following breakdown
Maintenance Operations: SOPs and Checking	↗ Deficient or absent: (1) Standard Operating Procedures (SOPs), (2) operational instructions and/or policies, (3) company regulations, (4) controls to assess compliance with regulations and SOPs ↗ Includes deficiencies in technical documentation, unrecorded maintenance and the use of bogus parts/unapproved modifications
Maintenance Operations: Training Systems	↗ Omitted training, language skills deficiencies, qualifications and experience of maintenance crews, operational needs leading to training reductions, deficiencies in assessment of training or training resources such as manuals or CBT devices
Dispatch	See the following breakdown
Dispatch: Standard Operating Procedures and Checking	↗ Deficient or absent: (1) Standard Operating Procedures (SOPs), (2) operational instructions and/or policies, (3) company regulations, (4) controls to assess compliance with regulations and SOPs
Dispatch: Training Systems	↗ Omitted training, language skills deficiencies, qualifications and experience of dispatchers, operational needs leading to training reductions, deficiencies in assessment of training or training resources such as manuals or CBT devices
Other	↗ Not clearly falling within the other latent conditions

Note: All areas such as Training, Ground Operations or Maintenance include outsourced functions for which the operator has oversight responsibility.

2 Threats

Definition: An event or error that occurs outside the influence of the flight crew, but which requires crew attention and management if safety margins are to be maintained.

Mismanaged threat: A threat that is linked to or induces a flight crew error.

Environmental Threats	Examples
Meteorology	See the following breakdown
	↗ Thunderstorms
	↗ Poor visibility/IMC
	↗ Wind/wind shear/gusty wind
	↗ Icing conditions
Lack of Visual Reference	↗ Darkness/black hole effect ↗ Environmental situation, which can lead to spatial disorientation
Air Traffic Services	↗ Tough-to-meet clearances/restrictions ↗ Reroutes ↗ Language difficulties ↗ Controller errors ↗ Failure to provide separation (air/ground)
Wildlife/ Birds/Foreign Objects	↗ Self-explanatory
Airport Facilities	See the following breakdown
	↗ Poor signage, faint markings ↗ Runway/taxiway closures
	↗ Contaminated runways/taxiways ↗ Poor braking action
	↗ Trenches/ditches ↗ Inadequate overrun area ↗ Structures in close proximity to runway/taxiway
	↗ Airport perimeter control/fencing ↗ Wildlife control

2 Threats (cont'd)

Navigational Aids	See the following breakdown
	↗ Ground navigation aid malfunction ↗ Lack or unavailability (e.g., ILS)
	↗ NAV aids not calibrated – unknown to flight crew
Terrain/ Obstacles	↗ Self-explanatory
Traffic	↗ Self-explanatory
Other	↗ Not clearly falling within the other environmental threats
Airline Threats	Examples
Aircraft Malfunction	↗ Technical anomalies/failures See breakdown (on the next page)
MEL item	↗ MEL items with operational implications
Operational Pressure	↗ Operational time pressure ↗ Missed approach/diversion ↗ Other non-normal operations
Cabin Events	↗ Cabin events ↗ Cabin crew errors ↗ Distractions/interruptions
Ground Events	↗ Aircraft loading events ↗ Fueling errors ↗ Agent interruptions ↗ Improper ground support ↗ Improper de-icing/anti-icing
Dispatch/ Paperwork	↗ Load sheet errors ↗ Crew scheduling events ↗ Late paperwork changes or errors
Maintenance Events	↗ Aircraft repairs on ground ↗ Maintenance log problems ↗ Maintenance errors
Dangerous Goods	↗ Carriage of articles or substances capable of posing a significant risk to health, safety or property when transported by air
Manuals/ Charts/ Checklists	↗ Incorrect/unclear chart pages or operating manuals ↗ Checklist layout/design issues
Other	↗ Not clearly falling within the other airline threats

2 Threats (cont'd)

Aircraft Malfunction Breakdown (Technical Threats)	Examples
Extensive/ Uncontained Engine Failure	↗ Damage due to non-containment
Contained Engine Failure / Power plant Malfunction	↗ Engine overheat ↗ Propeller failure ↗ Failure affecting power plant components
Gear/Tire	↗ Failure affecting parking, taxi, take-off or landing
Brakes	↗ Failure affecting parking, taxi, take-off or landing
Flight Controls	See the following breakdown
Primary Flight Controls	↗ Failure affecting aircraft controllability
Secondary Flight Controls	↗ Failure affecting flaps, spoilers
Structural Failure	↗ Failure due to flutter, overload ↗ Corrosion/fatigue ↗ Engine separation
Fire/Smoke in Cockpit/ Cabin/Cargo	↗ Fire due to aircraft systems ↗ Other fire causes
Avionics, Flight Instruments	↗ All avionics except autopilot and FMS ↗ Instrumentation, including standby instruments
Autopilot/FMS	↗ Self-explanatory
Hydraulic System Failure	↗ Self-explanatory
Electrical Power Generation Failure	↗ Loss of all electrical power, including battery power
Other	↗ Not clearly falling within the other aircraft malfunction threats

3 Flight Crew Errors

Definition: An observed flight crew deviation from organizational expectations or crew intentions.

Mismanaged error: An error that is linked to or induces additional error or an undesired aircraft state.

Aircraft Handling Errors	Examples
Manual Handling/ Flight Controls	↗ Hand flying vertical, lateral, or speed deviations ↗ Approach deviations by choice (e.g., flying below the glide slope) ↗ Missed runway/taxiway, failure to hold short, taxi above speed limit ↗ Incorrect flaps, speed brake, autobrake, thrust reverser or power settings
Ground Navigation	↗ Attempting to turn down wrong taxiway/runway ↗ Missed taxiway/runway/gate
Automation	↗ Incorrect altitude, speed, heading, autothrottle settings, mode executed, or entries
Systems/ Radios/ Instruments	↗ Incorrect packs, altimeter, fuel switch settings, or radio frequency dialed
Other	↗ Not clearly falling within the other errors

Procedural Errors	Examples
Standard Operating Procedures adherence / Standard Operating Procedures Cross-verification	↗ Intentional or unintentional failure to cross-verify (automation) inputs ↗ Intentional or unintentional failure to follow SOPs ↗ PF makes own automation changes ↗ Sterile cockpit violations
Checklist	See the following breakdown
Normal Checklist	↗ Checklist performed from memory or omitted ↗ Wrong challenge and response ↗ Checklist performed late or at wrong time ↗ Checklist items missed
Abnormal Checklist	↗ Checklist performed from memory or omitted ↗ Wrong challenge and response ↗ Checklist performed late or at wrong time ↗ Checklist items missed
Callouts	↗ Omitted take-off, descent, or approach callouts
Briefings	↗ Omitted departure, take-off, approach, or handover briefing; items missed ↗ Briefing does not address expected situation

3 Flight Crew Errors (cont'd)

Documentation	See the following breakdown
	↗ Wrong weight and balance information, wrong fuel information
	↗ Wrong ATIS, or clearance recorded
	↗ Misinterpreted items on paperwork
	↗ Incorrect or missing log book entries
Failure to go-around after destabilisation during approach	↗ Flight crew does not execute a go-around after stabilization requirements are not met
Other Procedural	↗ Administrative duties performed after top of descent or before leaving active runway ↗ Incorrect application of MEL
Communication Errors	Examples
Crew to External Communication	See breakdown
With Air Traffic Control	↗ Flight crew to ATC – missed calls, misinterpretation of instructions, or incorrect read-backs ↗ Wrong clearance, taxiway, gate or runway communicated
With Cabin Crew	↗ Errors in Flight to Cabin Crew communication ↗ Lack of communication
With Ground Crew	↗ Errors in Flight to Ground Crew communication ↗ Lack of communication
With Dispatch	↗ Errors in Flight Crew to Dispatch ↗ Lack of communication
With Maintenance	↗ Errors in Flight to Maintenance Crew ↗ Lack of communication
Pilot-to-Pilot Communication	↗ Within-crew miscommunication ↗ Misinterpretation

4 Undesired Aircraft States (UAS)

Definition: A flight-crew-induced aircraft state that clearly reduces safety margins; a safety-compromising situation that results from ineffective error management. An undesired aircraft state is **recoverable**.

Mismanaged UAS: A UAS that is linked to or induces additional flight crew errors.

Undesired Aircraft States	Breakdown
Aircraft Handling	↗ Abrupt Aircraft Control
	↗ Vertical, Lateral or Speed Deviations
	↗ Unnecessary Weather Penetration
	↗ Unauthorized Airspace Penetration
	↗ Operation Outside Aircraft Limitations
	↗ Unstable Approach
	↗ Continued Landing after Unstable Approach
	↗ Long, Floated, Bounced, Firm, Off-Centerline Landing ↗ Landing with excessive crab angle
	↗ Rejected Take-off after V1
	↗ Controlled Flight Towards Terrain
	↗ Other
Ground Navigation	↗ Proceeding towards wrong taxiway/runway
	↗ Wrong taxiway, ramp, gate or hold spot
	↗ Runway/taxiway incursion
	↗ Ramp movements, including when under marshalling
	↗ Loss of aircraft control while on the ground
	↗ Other

4 Undesired Aircraft States (UAS) (cont'd)

Incorrect Aircraft Configurations	↗ Brakes, Thrust Reversers, Ground Spoilers
	↗ Systems (Fuel, Electrical, Hydraulics, Pneumatics, Air Conditioning, Pressurization/ Instrumentation
	↗ Landing Gear
	↗ Flight Controls/Automation
	↗ Engine
	↗ Weight & Balance
	↗ Other

5 End States

Definition: An end state is a reportable event. It is **unrecoverable**.

End States	Definitions
Controlled Flight Into Terrain (CFIT)	↗ In-flight collision with terrain, water, or obstacle without indication of loss of control
Loss of Control In-flight	↗ Loss of aircraft control while in-flight
Runway Collision	↗ Any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle, person or wildlife on the protected area of a surface designated for the landing and take-off of aircraft and resulting in a collision
Mid-air Collision	↗ Collision between aircraft in flight
Runway Excursion	↗ A veer off or overrun off the runway or taxiway surface
In-flight Damage	Damage occurring while airborne, including: ↗ Weather-related events, technical failures, bird strikes and fire/smoke/fumes
Ground Damage	Damage occurring while on the ground, including: ↗ Occurrences during (or as a result of) ground handling operations ↗ Collision while taxiing to or from a runway in use (excluding a runway collision) ↗ Foreign object damage ↗ Fire/smoke/fumes

5 End States (cont'd)

Undershoot	↗ A touchdown off the runway surface
Hard Landing	↗ Any hard landing resulting in substantial damage
Gear-up Landing/ Gear Collapse	↗ Any gear-up landing/collapse resulting in substantial damage (without a runway excursion)
Tailstrike	↗ Tailstrike resulting in substantial damage
Off Airport Landing/Ditching	↗ Any controlled landing outside of the airport area

6 Flight Crew Countermeasures

The following list includes countermeasures that the flight crew can take. Countermeasures from other areas, such as ATC, ground operations personnel and maintenance staff, are not considered at this time.

Team Climate		
Countermeasure	Definition	Example Performance
Communication Environment	Environment for open communication is established and maintained	Good cross talk – flow of information is fluid, clear, and direct No social or cultural disharmonies. Right amount of hierarchy gradient Flight Crew member reacts to assertive callout of other crew member(s)
Leadership	See the following breakdown	
	Captain should show leadership and coordinate flight deck activities	In command, decisive, and encourages crew participation
	First Officer (FO) is assertive when necessary and is able to take over as the leader	FO speaks up and raises concerns
Overall crew performance	Overall, crew members should perform well as risk managers	Includes Flight, Cabin, Ground crew as well as their interactions with ATC
Other	Not clearly falling within the other categories	

6 Flight Crew Countermeasures (cont'd)

Planning		
SOP Briefing	The required briefing should be interactive and operationally thorough	Concise and not rushed – bottom lines are established
Plans Stated	Operational plans and decisions should be communicated and acknowledged	↗ Shared understanding about plans – "Everybody on the same page"
Contingency Management	Crew members should develop effective strategies to manage threats to safety	↗ Threats and their consequences are anticipated. ↗ Use all available resources to manage threats
Other	Not clearly falling within the other categories	
Execution		
Monitor/ Cross-check	Crew members should actively monitor and cross-check flight path, aircraft performance, systems and other crew members	Aircraft position, settings, and crew actions are verified
Workload Management	Operational tasks should be prioritized and properly managed to handle primary flight duties	↗ Avoid task fixation. ↗ Do not allow work overload
Automation Management	Automation should be properly managed to balance situational and/or workload requirements	↗ Brief automation setup. ↗ Effective recovery techniques from anomalies
Taxiway/Runway Management	Crew members use caution and kept watch outside when navigating taxiways and runways	Clearances are verbalized and understood – airport and taxiway charts or aircraft cockpit moving map displays are used when needed
Other	Not clearly falling within the other categories	
Review/Modify		
Evaluation of Plans	Existing plans should be reviewed and modified when necessary	Crew decisions and actions are openly analyzed to make sure the existing plan is the best plan
Inquiry	Crew members should not be afraid to ask questions to investigate and/or clarify current plans of action	"Nothing taken for granted" attitude – Crew members speak up without hesitation
Other	Not clearly falling within the other categories	

7 Additional Classifications

Additional Classification	Breakdown
Insufficient Data	Accident does not contain sufficient data to be classified
Incapacitation	Crew member unable to perform duties due to physical or psychological impairment
Fatigue	Crew member unable to perform duties due to fatigue
Spatial Disorientation and Spatial/ Somatogravic Illusion (SGI)	SGI is a form of spatial disorientation that occurs when a shift in the resultant gravitoinertial force vector created by a sustained linear acceleration is misinterpreted as a change in pitch or bank attitude

Image courtesy of Embraer

Annex 3

2013 Accidents Summary

DATE	MANUFACTURER	AIRCRAFT	OPERATOR	LOCATION	PHASE
2013-01-02	Saab	340	Sol Lineas Aereas	El Plumerillo Airport, Mendoza, Argentina	TOF
2013-01-17	Boeing	777	Air France	Miami International Airport, FL, USA	PRF
2013-01-25	Airbus	A321	Ural Airlines	Kazan International Airport, Tatarstan, Russia	GOA
2013-01-25	Boeing	MD-11	FedEx	Denver International Airport, Denver, CO, USA	LND
2013-01-29	Bombardier (Canadair)	CRJ	Scat	(near) Almaty International Airport, Almaty, Kazakhstan	APR
2013-02-02	ATR	ATR 72	Carpatair	Leonardo da Vinci-Fiumicino Airport, Rome, Italy	LND
2013-02-06	Airbus	A320	Tunisair	Tunis-Carthage International Airport, Tunis, Tunisia	LND
2013-02-09	Beechcraft	1900	Pacific Coastal Airlines	Blue River Airport, Blue River, BC, Canada	LND
2013-02-11	Boeing	737	Pakistan International Airlines	Muscat International Airport, Muscat, Oman	LND
2013-02-13	Antonov	An-24	South Airlines	Donetsk International Airport, Donetsk, Ukraine	APR
2013-02-28	Let	Let 410	Heli Air Services	Wau, South Sudan	LND
2013-03-04	Fokker	F.50	CAA - Compagnie Africaine d'Aviation	Goma International Airport, Goma, Congo (Democratic Republic)	APR
2013-03-05	Airbus	A330	Lufthansa	Chicago O'Hare, IL, USA	TOF
2013-03-05	ATR	ATR 72	Airlinair	Toulouse, France	LND
2013-03-07	Fairchild (Swearingen)	Metro	Binair Aero Service	Dublin International Airport, Dublin, Ireland	LND
2013-03-08	Beechcraft	1900	ACE Air Cargo	(near) Dillingham, AK, USA	APR
2013-03-29	Airbus	A321	Air Mediterranee	Lyon Saint-Exupéry, France	LND
2013-04-05	Airbus	A321	US Airways	Las Vegas, NV, United States	LND
2013-04-07	Hawker Beechcraft	1900	Sahel Aviation Service	(in sea off) Sao Tome, Sao Tome and Principe	APR

SERVICE	ORIGIN	PROPULSION	SEVERITY	SUMMARY
Passenger	Western	Turboprop	Hull Loss	Gear collapse after excursion from taxiway
Passenger	Western	Jet	Substantial Damage	Struck by aircraft while parked
Passenger	Western	Jet	Substantial Damage	Aircraft collided with localizer antenna during go-around
Cargo	Western	Jet	Substantial Damage	Tailstrike during landing
Passenger	Western	Jet	Hull Loss	Impacted ground on approach
Passenger	Western	Turboprop	Hull Loss	Runway excursion preceded by a hard landing and subsequent gear collapse
Passenger	Western	Jet	Hull Loss	Runway excursion - veer off
Passenger	Western	Turboprop	Substantial Damage	Runway excursion - veer off
Passenger	Western	Jet	Substantial Damage	Gear collapse on landing
Passenger	Eastern	Turboprop	Hull Loss	Impacted ground on approach
Ferry	Eastern	Turboprop	Hull Loss	Nosegear collapse and fire on landing
Cargo	Western	Turboprop	Hull Loss	Impacted terrain short of the runway
Passenger	Western	Jet	Substantial Damage	Tailstrike during take off
Passenger	Western	Turboprop	Substantial Damage	Nose gear malfunction during roll out
Cargo	Western	Turboprop	Substantial Damage	Nose-gear collapse during landing
Cargo	Western	Turboprop	Hull Loss	Impacted mountains on approach
Passenger	Western	Jet	Substantial Damage	Runway overrun in fog
Passenger	Western	Jet	Substantial Damage	Tailstrike during landing
Ferry	Western	Turboprop	Hull Loss	Aircraft missing at sea

DATE	MANUFACTURER	AIRCRAFT	OPERATOR	LOCATION	PHASE
2013-04-13	Airbus	A330	TAP Portugal	Brasilia International Airport, Brasilia, Brazil	TXO
2013-04-13	Boeing	737	Lion Air	Denpasar, Indonesia	APR
2013-04-16	Airbus	A321	Asiana Airlines	Incheon International Airport, Seoul, South Korea	LND
2013-04-16	Boeing	767	Aeromexico	Barajas International Airport, Madrid, Spain	TOF
2013-04-28	Bombardier	Dash 8	Porter Airlines	Toronto City, ON, Canada	ESD
2013-04-28	Boeing	777	Saudia	King Abdul Aziz International Airport, Jeddah, Saudi Arabia	ESD
2013-04-29	Boeing	747	National Airlines	Bagram Airport, Bagram, Afghanistan	TOF
2013-05-01	Embraer	ERJ-145	ExpressJet Airlines	Newark - Liberty International Airport,New York,New York,United States	TXO
2013-05-16	Xian	MA-60	Myanma Airways	Mong-Hsat, Myanmar	LND
2013-05-18	Bombardier	Dash 8	Piedmont Airlines	Newark - Liberty International Airport, NJ, United States	LND
2013-05-19	Boeing	747	China Airlines	(in-flight near) Atlanta, GA, USA	APR
2013-05-23	ATR	ATR 72	Aer Arann Regional	Manchester, UK	AES
2013-05-24	Airbus	A319	British Airways	Heathrow International Airport, London, United Kingdom	TOF
2013-05-24	Airbus	A320	Air VIA	Varna International Airport, Varna, Bulgaria	LND
2013-05-26	Bombardier	Dash 8	Porter Airlines	Sault Ste. Marie, ON, Canada	LND
2013-05-31	BAE Systems	ATP Bulk Freighter	Deraya Air Taxi	Wamena, Indonesia	LND
2013-06-01	Fairchild Dornier	Do-228	Sita Air	Simikot Airport, Simikot, Nepal	LND
2013-06-02	Airbus	A320	Cebu Pacific	Bangoy International Airport, Davao, Philippines	LND
2013-06-07	Embraer	ERJ-145	China Eastern Airlines Jiangsu	Hongqiao Airport, Shanghai, China	LND
2013-06-08	Airbus	A320	Wizz Air	Fiumicino Airport, Rome, Italy	APR
2013-06-10	Xian	MA-60	Merpati Nusantara Airlines	Eltari Airport, Kupang, Indonesia	LND
2013-06-10	Xian	MA-60	Myanma Airways	Kawthoung airport, Myanmar	LND
2013-06-13	Saab	340	Sky Bahamas	Marsh Harbour Airport, Marsh Harbour, Bahamas	LND
2013-06-29	Embraer	EMB-110	Batair Cargo	(near) Francistown Airport, Francistown, Botswana	APR
2013-07-06	Boeing	777	Asiana Airlines	San Francisco - International, CA, USA	LND
2013-07-22	Boeing	737	Southwest Airlines	New York - La Guardia, NY, USA	LND

SERVICE	ORIGIN	PROPULSION	SEVERITY	SUMMARY
Passenger	Western	Jet	Substantial Damage	Wingtip struck lamp post
Passenger	Western	Jet	Hull Loss	Undershoot on approach
Passenger	Western	Jet	Substantial Damage	Tailstrike during landing
Passenger	Western	Jet	Hull Loss	Heavy tailstrike on take-off
Passenger	Western	Turboprop	Substantial Damage	Struck baggage cart during push-back
Passenger	Western	Jet	Substantial Damage	Engine struck pushback tug
Cargo	Western	Jet	Hull Loss	Stall after take-off
Passenger	Western	Jet	Substantial Damage	Aircraft stabilizer struck while lining up for take-off
Passenger	Eastern	Turboprop	Substantial Damage	Overshot runway during landing
Passenger	Western	Turboprop	Substantial Damage	All gear-up landing
Cargo	Western	Jet	Substantial Damage	Flap dropped on approach
Passenger	Western	Turboprop	Substantial Damage	Leading edge struck steps while parking
Passenger	Western	Jet	Substantial Damage	Damage from engine cowling doors detaching in flight
Passenger	Western	Jet	Substantial Damage	Runway overrun
Passenger	Western	Turboprop	Substantial Damage	Touched down hard and struck tail
Cargo	Eastern	Turboprop	Substantial Damage	Runway veer-off and nose gear collapse
Passenger	Western	Turboprop	Hull Loss	Landed short of the runway
Passenger	Western	Jet	Substantial Damage	Runway veer-off
Passenger	Western	Jet	Substantial Damage	Runway veer-off
Passenger	Western	Jet	Substantial Damage	Left main gear-up landing
Passenger	Eastern	Turboprop	Hull Loss	Landed short of runway
Passenger	Eastern	Turboprop	Substantial Damage	Runway veer-off
Passenger	Western	Turboprop	Hull Loss	Bounced landing and runway excursion
Ferry	Western	Turboprop	Hull Loss	Impacted ground on approach
Passenger	Western	Jet	Hull Loss	Impacted seawall short of runway
Passenger	Western	Jet	Hull Loss	Hard landing and nose-gear collapse

DATE	MANUFACTURER	AIRCRAFT	OPERATOR	LOCATION	PHASE
2013-07-28	Bombardier	Dash 8	Spicejet	Tuticorin, Vaagaikulam, India	LND
2013-07-29	Saab	340	Air Urga	Lubumbashi - International, DR Congo	TOF
2013-08-06	Fokker	F.50	Mid Airlines	Khartoum, Sudan	ESD
2013-08-09	Antonov	An-12	Ukraine Air Alliance	Halle Airport, Leipzig, Germany	PRF
2013-08-14	Airbus	A300	UPS Airlines	Birmingham, AL, USA	APR
2013-08-20	Fairchild (Swearingen)	Metro III	AeroCon	Sucre - Juana Azurduy de Padilla, Bolivia	LND
2013-08-21	Fairchild (Swearingen)	Metro III	Kolob Canyons Air Services	Laredo - International, TX, USA	LND
2013-08-25	Antonov	An-26	Transom Airways	Guriceel Airstrip, Guriceel, Somalia	LND
2013-09-01	Beechcraft	1900	Great Lakes Airlines	Telluride, CO, USA	LND
2013-09-08	Airbus	A330	Thai Airways International	Suvarnabhumi International Airport, Bangkok, Thailand	LND
2013-09-27	Bombardier	Dash 8	Croatia Airlines	Kloten International Airport, Zurich, Switzerland	APR
2013-09-27	Let	L-410	Blue Sky Aviation	Musiara Airstrip, Masai Mara Game Reserve, Kenya	LND
2013-09-27	Boeing	747	nasair	Nouakchott International Airport, Nouakchott, Mauritania	TXO
2013-09-29	Airbus	A320	Alitalia	Fiumicino International Airport, Rome, Italy	APR
2013-10-03	Embraer	EMB-120	Associated Aviation Ltd	Murtala Muhammed Airport, Lagos, Nigeria	ICL
2013-10-06	Saab	340	Nok Mini	Udon Thani International Airport, Udon Thani, Thailand	TXI
2013-10-16	ATR	ATR 72	Lao Airlines	Mekong River, (near) Pakse, Laos	APR
2013-10-16	BAE Systems (Hawker Siddeley)	748	Wasaya Airways	Kenora Airport, Ottawa, Ontario, Canada	TXI
2013-10-19	ATR	ATR 42	Air Niugini	Madang Airport, Madang, Papua New Guinea	RTO
2013-10-19	BAE Systems	146	Skyjet Airines	Polillo Airport, Balesin, Quezon, Philippines	LND
2013-10-23	Beechcraft	1900	Frontier Flying Service	Homer Airport, Homer, AK, United States	LND
2013-10-25	Fokker	F.27	Miniliner	Charles de Gaulle International Airport, Paris, France	ICL
2013-11-03	Fairchild (Swearingen)	Metro	AeroCon	Riberalta Airport, Riberalta, Bolivia	LND
2013-11-05	Bombardier	Dash 8	Sunstate Airlines	Brisbane, QLD, Australia	LND
2013-11-10	Fairchild (Swearingen)	Metro	Bearskin Airlines	Red Lake, ON, Canada	APR
2013-11-17	Boeing	737	Tatarstan Air	Kazan Airport, Kazan, Russia	GOA

SERVICE	ORIGIN	PROPULSION	SEVERITY	SUMMARY
Passenger	Western	Turboprop	Substantial Damage	Tailstrike during landing
Passenger	Western	Turboprop	Hull Loss	Runway veer-off on take-off
Passenger	Western	Turboprop	Substantial Damage	Propeller struck ground power unit during start-up
Cargo	Eastern	Turboprop	Hull Loss	Caught fire during start-up
Cargo	Western	Jet	Hull Loss	Impacted ground short of the runway
Passenger	Western	Turboprop	Substantial Damage	Runway veer-off during landing
Cargo	Western	Turboprop	Substantial Damage	Gear-up landing
Passenger	Eastern	Turboprop	Substantial Damage	Overran the unimproved runway during landing and struck a rock
Passenger	Western	Turboprop	Substantial Damage	Main gear collapse during landing
Passenger	Western	Jet	Substantial Damage	Right undercarriage failure during landing
Passenger	Western	Turboprop	Substantial Damage	Nose gear up landing
Passenger	Eastern	Turboprop	Substantial Damage	Struck zebras while landing
Passenger	Western	Jet	Substantial Damage	Wing struck light pole
Passenger	Western	Jet	Substantial Damage	Main gear did not extend
Passenger	Western	Turboprop	Hull Loss	Stall after take-off
Passenger	Western	Turboprop	Substantial Damage	Taxiway excursion and nose-gear failure
Passenger	Western	Turboprop	Hull Loss	Impacted water 7km short of airfield
Cargo	Western	Turboprop	Substantial Damage	Nose undercarriage slow collapse during taxi
Cargo	Western	Turboprop	Hull Loss	Overran runway following rejected take-off
Passenger	Western	Jet	Hull Loss	Overran runway during landing roll
Passenger	Western	Turboprop	Substantial Damage	Gear collapse during landing roll
Cargo	Western	Turboprop	Hull Loss	Propeller separated during initial climb
Passenger	Western	Turboprop	Hull Loss	Destroyed by fire after a runway excursion
Passenger	Western	Turboprop	Substantial Damage	Tailstrike during landing
Passenger	Western	Turboprop	Hull Loss	Impacted ground short of runway
Passenger	Western	Jet	Hull Loss	Lost control during go-around

DATE	MANUFACTURER	AIRCRAFT	OPERATOR	LOCATION	PHASE
2013-11-29	Embraer	EMB-190	Linhas Aereas de Mocambique	200km east of Rundu, Namibia	CRZ
2013-12-02	Airbus	A320	LAN Ecuador	Buenos Aires, Argentina	TXI
2013-12-02	Fairchild (Swearingen)	Metro	IBC Airways	(near) La Alianza, Puerto Rico	DST
2013-12-04	Airbus	A320	Swiss International Air Lines	Heathrow Airport, London, United Kingdom	LND
2013-12-04	Boeing	747	Veteran Airlines	Abuja International Airport, Abuja, Nigeria	LND
2013-12-05	Boeing	767	Delta Air Lines	Madrid, Spain	TOF
2013-12-11	ATR	ATR 72	Binter Canarias	Tenerife Norte, Spain	LND
2013-12-19	Boeing	737	Nova Airways	Juba Airport, Juba, South Sudan	LND
2013-12-22	Boeing	747	British Airways	O R Tambo International Airport, Johannesburg, South Africa	TXO
2013-12-24	Airbus	A330	Virgin Atlantic Airways	Vieux Fort Quarter, Saint Lucia	LND

SERVICE	ORIGIN	PROPULSION	SEVERITY	SUMMARY
Passenger	Western	Jet	Hull Loss	Steep descent until impact
Passenger	Western	Jet	Substantial Damage	Aircraft struck by airstairs blown into fuselage by wind
Cargo	Western	Turboprop	Hull Loss	In-flight breakup
Passenger	Western	Jet	Substantial Damage	Tailstrike during landing
Cargo	Western	Jet	Hull Loss	Overran displaced threshold and struck construction equipment
Passenger	Western	Jet	Substantial Damage	Burst tire resulting in damage to wing
Passenger	Western	Turboprop	Substantial Damage	Runway veer-off
Passenger	Western	Jet	Substantial Damage	Nose-gear collapse during
Passenger	Western	Jet	Substantial Damage	Struck building with wingtip during taxi
Passenger	Western	Jet	Substantial Damage	River flood resulted in mud on runway during short final

Annex 4

2013 Table of Sectors

This table provides a breakdown of the sectors used in the production of rates for this report by aircraft type and year.
It is up-to-date as of the time of report production.

MANUFACTURER	MODEL	2009	2010	2011	2012	2013
Aerospatiale	262	1,233	1,340	1,340	1,340	1,340
Airbus	A300	278,540	250,125	223,888	206,198	173,405
Airbus	A310	97,812	85,318	84,949	78,556	62,441
Airbus	A318	104,301	104,551	96,043	99,796	87,480
Airbus	A319	1,981,691	2,077,674	2,163,629	2,186,714	2,236,626
Airbus	A320	3,334,914	3,672,861	4,190,723	4,668,200	5,212,210
Airbus	A321	768,482	876,942	966,721	1,045,937	1,184,208
Airbus	A330	530,139	601,595	691,920	759,379	841,120
Airbus	A340	199,303	201,748	202,660	192,137	177,738
Airbus	A380	8,605	16,906	28,069	41,779	57,600
Aircraft Industries (LET)	410	120,495	104,353	87,171	79,169	77,929
Antonov	An-12	13,541	12,560	10,870	9,693	9,881
Antonov	An-22	23	-	-	-	-
Antonov	An-24	79,939	73,079	69,375	53,880	50,096
Antonov	An-26	30,100	26,970	22,820	21,572	20,941
Antonov	An-28	9,236	7,745	4,531	3,919	3,970
Antonov	An-30	1,360	1,056	515	236	338
Antonov	An-32	3,421	3,707	2,751	2,425	2,276
Antonov	An-38	3,040	3,615	4,259	4,275	4,260
Antonov	An-72 / An-74	751	602	102	11	30
Antonov	An-124	5,784	5,572	5,559	5,833	6,193
Antonov	An-140	1,881	2,018	2,595	2,967	3,268
Antonov	An-148	1,390	5,045	7,044	7,122	11,028
Antonov	An-158	-	-	-	-	886
Antonov	An-225	19	48	48	48	48
ATR	ATR 42	460,333	430,535	435,813	395,561	382,775

MANUFACTURER	MODEL	2009	2010	2011	2012	2013
ATR	ATR 72	755,180	836,532	941,628	983,851	1,035,203
Avro	RJ	234,579	199,128	182,411	137,473	141,922
BAE Systems	ATP	40,486	29,714	26,272	23,685	26,109
BAE Systems	Jetstream	168,305	157,298	150,698	141,114	145,575
BAE Systems	Jetstream 41	92,977	81,498	90,860	92,748	91,381
BAE Systems	146	90,842	76,592	67,754	62,488	64,786
BAE Systems (BAC)	One-Eleven	2,182	385	-	-	-
BAE Systems (Hawker Siddeley)	748	21,276	18,424	14,799	13,046	12,255
Boeing	707	3,285	1,218	237	252	68
Boeing	717	300,403	288,788	270,951	281,410	284,544
Boeing	727	159,169	136,289	113,031	92,196	61,936
Boeing	737	7,547,513	7,918,370	8,322,613	8,575,347	8,909,674
Boeing	747	465,849	442,688	414,971	392,121	370,920
Boeing	757	901,791	850,441	854,093	779,763	793,802
Boeing	767	713,774	732,147	735,431	753,869	790,774
Boeing	777	624,303	681,133	722,873	785,703	873,968
Boeing	787	-	-	47	4,188	31,234
Boeing (Douglas)	DC-3	1,710	849	800	793	851
Boeing (Douglas)	DC-8	25,518	17,813	14,979	8,642	5,034
Boeing (Douglas)	DC-9	177,606	152,100	105,623	85,551	86,904
Boeing (Douglas)	DC-10	71,789	66,041	63,349	56,777	52,052
Boeing (Douglas)	MD-11	117,180	124,448	120,722	115,828	111,158
Boeing (Douglas)	MD-80	963,254	874,774	831,404	745,667	724,982
Boeing (Douglas)	MD-90	176,711	149,579	106,714	98,465	104,681
Canadair (Bombardier)	CRJ	2,619,546	2,660,695	2,642,405	2,541,066	2,493,556
CASA / IAe	212	34,540	34,814	32,412	29,188	28,321
CASA / IAe	235	3,035	1,637	1,091	2,139	2,172
Convair	580	37,548	34,910	34,303	34,925	34,029
De Havilland (Bombardier)	DHC-6	684,141	683,845	674,349	669,751	671,089
De Havilland (Bombardier)	DHC-7	63,625	53,154	47,622	46,365	45,125
De Havilland (Bombardier)	DHC-8	1,567,313	1,611,098	1,690,108	1,733,312	1,792,458
Embraer	110 Bandeirante	58,917	51,495	37,131	32,376	28,847
Embraer	120 Brasilia	240,144	221,525	200,243	182,674	175,837
Embraer	135 / 140 / 145	1,405,357	1,446,354	1,451,737	1,458,296	1,360,813
Embraer	170 / 175	533,291	575,585	587,855	599,301	649,162
Embraer	190 / 195	469,645	626,813	759,027	938,571	1,073,646
Fairchild (Swearingen)	Metro	674,355	662,564	633,174	619,007	613,812
Fairchild Dornier	328JET	47,991	23,122	6,684	5,844	6,815

MANUFACTURER	MODEL	2009	2010	2011	2012	2013
Fairchild Dornier	228	164,707	153,646	150,342	146,858	136,512
Fairchild Dornier	328	90,761	91,538	83,834	61,895	51,226
Fokker	F27	16,529	10,266	8,304	9,211	8,480
Fokker	F28	19,364	15,409	12,812	6,914	2,749
Fokker	50	194,229	169,331	150,868	144,274	138,718
Fokker	70	73,066	72,607	79,271	81,056	71,568
Fokker	100	307,447	301,522	243,798	215,795	206,714
Gippsland Aeronautics	N22B / N24A Nomad	588	476	402	294	292
Gulfstream Aerospace (Grumman)	Gulfstream	1,767	1,616	763	632	510
Harbin	Y12	9,880	10,264	10,349	10,593	10,345
Hawker Beechcraft	C99	216,593	209,329	205,242	202,928	196,516
Hawker Beechcraft	1900	643,553	616,287	638,671	596,147	569,896
Ilyushin	Il-18	4,211	2,922	2,438	2,382	2,194
Ilyushin	Il-62	5,894	5,247	2,538	1,944	2,113
Ilyushin	Il-76	25,542	24,424	21,411	19,558	20,008
Ilyushin	Il-86	5,103	2,127	121	-	-
Ilyushin	Il-96	4,754	5,486	5,337	5,677	5,659
Ilyushin	Il-114	754	793	987	1,112	1,216
Lockheed Martin	L-182 / L-282 / L-382 (L-100) Hercules	42,451	39,524	35,782	32,792	31,555
Lockheed Martin	L-188	3,151	2,213	1,745	1,361	235
Lockheed Martin	L-1011 Tristar	1,044	1,719	1,330	1,446	1,431
NAMC	YS-11	8,079	7,301	6,193	4,536	3,390
Saab	340	461,918	428,583	400,349	347,929	343,367
Saab	2000	49,986	49,905	53,295	51,227	50,269
Shaanxi	Y-8	25	32	32	16	-
Shorts	SC.5 Belfast	18	-	-	-	-
Shorts	Skyvan (SC-7)	8,877	7,569	8,752	7,913	7,233
Shorts	330	20,364	16,715	15,697	15,725	15,663
Shorts	360	75,256	68,692	65,231	55,441	55,393
Sukhoi	Superjet 100	-	-	1,790	7,670	13,319
Tupolev	Tu-134	53,686	36,588	25,469	13,904	12,064
Tupolev	Tu-154	96,734	72,463	45,692	32,495	30,078
Tupolev	Tu-204 / Tu-214	11,939	12,955	13,118	13,498	11,635
Xian	MA-60	2,396	2,494	3,848	4,017	4,011
Yakovlev	Yak-40	76,830	57,350	44,442	35,564	30,082
Yakovlev	Yak-42 / Yak-142	35,532	32,356	27,085	20,977	17,425

Source: Ascend - A Flightglobal Advisory Service

LIST OF ACRONYMS

ACAS	Airborne Collision Avoidance Systems
ACTF	IATA Accident Classification Task Force
AES	Arrival/Engine Shutdown (ATA Phase of Flight)
AFI	Africa (IATA Region)
AIP	Aeronautical Information Publication
ANSP	Aviation Navigation Service Provider
AOC	Air Operator's Certificate
APR	Approach (ATA Phase of Flight)
ASPAC	Asia/Pacific (IATA Region)
ATA	Air Transport Association
ATC	Air Traffic Control
CA	Captain
CBT	Computer-Based Training
CEO	Chief Executive Officer
CFIT	Controlled Flight Into Terrain
CIS	Commonwealth of Independent States (IATA Region)
COO	Chief Operating Officer
CRM	Crew Resource Management
CRZ	Cruise (ATA Phase of Flight)
CSWG	IATA Cabin Safety Working Group
CVR	Cockpit Voice Recorder
DFDR	Digital Flight Data Recorder
DGB	IATA Dangerous Goods Board
DGR	Dangerous Goods Regulations
DH	Decision Height
DST	Descent (ATA Phase of Flight)
ECL	En Route Climb (ATA Phase of Flight)
E-GPWS	Enhanced Ground Proximity Warning System
ERPTF	IATA Emergency Response Planning Task Force
ESD	Engine Start/Depart (ATA Phase of Flight)
ETOPS	Extended-Range Twin-Engine Operations
EUR	Europe (IATA Region)
FAA	Federal Aviation Administration
FDA	Flight Data Analysis
FLC	Flight Close (ATA Phase of Flight)
FLP	Flight Planning (ATA Phase of Flight)
FMS	Flight Management System
FO	First Officer
FOQA	Flight Operations Quality Assurance

FSF	Flight Safety Foundation
GDS	Ground Servicing (ATA Phase of Flight)
GOA	Go-around (ATA Phase of Flight)
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
GSIC	Global Safety Information Center
HL	Hull Loss
ICAO	International Civil Aviation Organization
ICL	Initial Climb (ATA Phase of Flight)
IFALPA	International Federation of Air Line Pilots' Associations
IFATCA	International Federation of Air Traffic Controllers' Associations
INOP	Inoperative
IOSA	IATA Operational Safety Audit
IRM	Incident Review Meeting
ISAGO	IATA Safety Audit for Ground Operations
ITDI	IATA Training and Development Institute
ITQI	IATA Training and Qualification Initiative
LATAM	Latin America and the Caribbean (IATA Region).
LND	Landing (ATA Phase of Flight)
LOSA	Line Operations Safety Audit
MDA	Minimum Descent Altitude
MEL	Minimum Equipment List
MENA	Middle East and North Africa (IATA Region)
MSTF	IATA Multidivisional Safety Task Force
NAM	North America (IATA Region)
NASIA	North Asia (IATA Region)
NAVaids	Navigational Aids
NOTAM	Notices to Airmen
OPC	IATA Operations Committee
PCMCIA	Personal Computer Memory Card International Association
PED	Portable Electronic Device
PF	Pilot Flying
PFS	IATA Partnership for Safety Program
PM	Pilot Monitoring
PRF	Pre-Flight (ATA Phase of Flight)
PSF	Post-flight (ATA Phase of Flight)
QAR	Quick Access Recorder
RA	Resolution Advisory

LIST OF ACRONYMS (Cont'd)

RAAS	Runway Awareness and Advisory System
RTO	Rejected Take-off (ATA Phase of Flight)
SD	Substantial Damage
SG	IATA Safety Group
SMS	Safety Management System
SOP	Standard Operating Procedures
STEADES	Safety Trend Evaluation, Analysis and Data Exchange System
TAWS	Terrain Awareness Warning System
TCAS	Traffic Alert and Collision Avoidance System
TCAS RA	Traffic Alert and Collision Avoidance System Resolution Advisory
TEM	Threat and Error Management
TIPH	Taxi into Position and Hold
TOF	Take-off (ATA Phase of Flight)
TXI	Taxi-in (ATA Phase of Flight)
TXO	Taxi-out (ATA Phase of Flight)
UAS	Undesired Aircraft State
WGS-84	World Geodetic System 1984

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