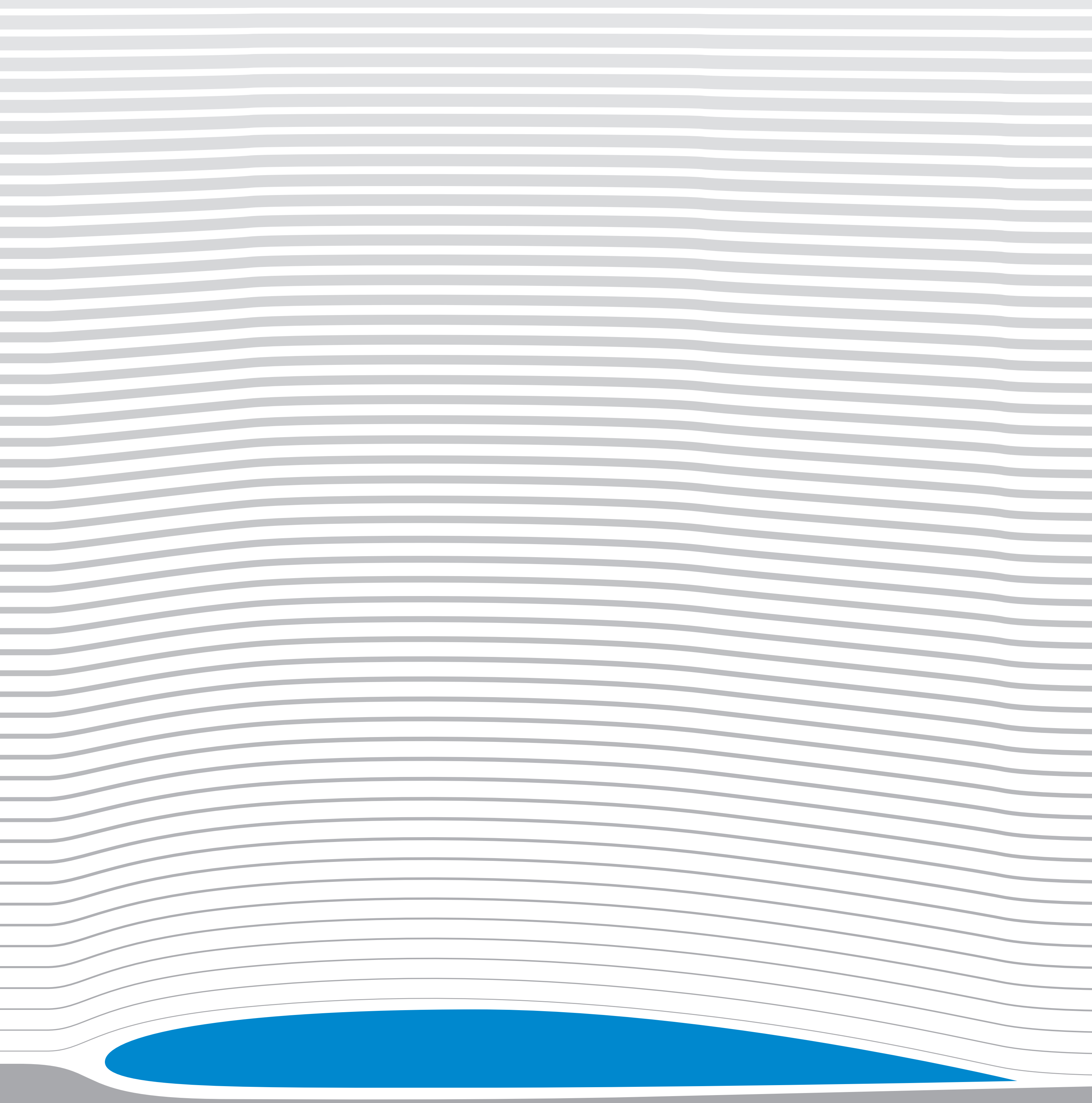
EASA
European Aviation Safety Agency

ANNUAL SAFETY REVIEW 2018

SUMMARY



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EUROPEAN AVIATION SAFETY AGENCY
SAFETY ANALYSIS AND RESEARCH DEPARTMENT

Designed in Luxembourg

EASA
European Aviation Safety Agency

Strategy & Safety Management Directorate
Safety Intelligence & Performance Department

Annual Safety Review 2018

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Disclaimer

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Foreword by the Executive Director

2017 has been an exceptional year for global airline safety, with fewer fatalities than at any time in the industry's history. Closer to home, we can see that in all aviation domains across the EASA Member States, the number of fatal accidents in 2017 has been lower than the average of the previous decade.

However, a regulator never rests on its laurels to ensure that this trend continues as the aviation system develops to face new challenges such as drones and cyber security risks. Indeed, by the end of January this year, the historically low figures for global airline safety for the whole of 2017 had already been exceeded. In the EASA Member States in 2017, there were fatalities in all non-commercial and specialised operation domains, as well as a fatal accident involving a medical flight that crashed in Italy with the loss of all 6 people on board.

Such accidents demonstrate the need to continuously drive safety improvements across the board, to share lessons learned. This is achieved through the safety actions that are identified in the European Plan for Aviation Safety (EPAS). In partnership with our Member States we are developing a better view of safety and defining a collective response. Additionally, EASA coordinates beyond Europe at a global level in order to help protect our citizens when they travel beyond our borders.

The Annual Safety Review will continue to evolve and with the launch of the Data4Safety, big-data programme, EASA is significantly enhancing the ability of the European Aviation System to be aware of potential safety risks. With this, we can react more quickly and help people to travel in the safest conditions.

Patrick Ky
Executive Director

Introduction

EASA would like to welcome you to the summary version of the 2018 EASA Annual Safety Review. This summary version provides a high level overview of aviation safety in Europe across all aviation domains. As with the previous edition, the ongoing European Safety Risk Management Process, in particular the valuable input from the Network of Analysts (NoA) and Collaborative Analysis Groups (CAGs), means that the analysis in this year's review provides not just a statistical summary of aviation safety in the EASA Member States (MS) but also identifies the most important safety challenges faced in European aviation today. This analysis drives the development of safety actions for the European Plan for Aviation Safety (EPAS) and harnesses the experience of both the EASA MS and industry to connect the data with the current and future priorities of the Agency.

The Annual Safety Review continues to evolve as we seek to constantly improve both the analysis performed and the conclusions that it reaches. Historically, the Review has focussed solely on a data analysis of safety performance in the EASA MS. For 2018, the introduction of the European Risk Classification Scheme has enabled a more detailed analysis of risk as well as the traditional details on Accidents and Serious Incidents. In following years you can expect 3 main analysis outputs from EASA:

- Immediately at the very start of January, EASA will publish a preliminary review of the main safety statistics from the previous year.

- In June, the traditional Annual Safety Review will be published providing a statistical review of safety performance in the EASA MS.

- Finally, when the EPAS is published in December, this will be accompanied by a more detailed review of the main safety risks to highlight how the actions directly link to safety improvement and risk mitigation.

What is the European Plan for Aviation Safety and why do we need it?

The EPAS seeks to continuously improve aviation safety throughout Europe. The Plan looks at aviation safety in a systemic manner and is based on available evidence of causal factors to accidents and incidents. Moreover, the Plan addresses emerging safety issues in order to ensure our high level of safety is maintained in the future. The EPAS is a key component of our integrated Safety Management System (SMS) at the European level, and is constantly being reviewed and improved. As an integral part of the EASA Work Programme, the Plan is developed by the Agency in consultation with the Member States and industry through the Safety Risk Management (SRM) process. The Member States are committed to the implementation of the Plan through their State programmes and plans. The current EPAS edition covers the 5-year period from 2018 to 2022.

The 3 main categories addressed in the EPAS are:

Systemic Issues: Such problems affect aviation as a whole and play a role in accidents and incidents. As they may affect operational issues, improvements can have an implicit effect on operational causes. An example of a systemic issue is the potential danger that can occur if tasks and responsibilities are not properly distributed among operational staff.

Operational Issues: These issues are closely related to events reported during operations and are brought to light through data analysis. The operational issues are split into 2 parts, which form the basis of the safety risk portfolios that are provided in this review:

- **Key Risk Areas:** The key risk areas are the accident outcomes that the EPAS seeks to stop from happening. Examples of these are aircraft upset (loss of control), runway excursions or runway collisions.

- **Safety Issues:** These are the causal and contributory factors that lead to the key risk areas (accident outcomes). Examples of safety issues are icing in flight, or pilot awareness and decision making.

Emerging Issues: These are suspected problems that are to be expected or anticipated in the future. Examples of emerging issues include new cybersecurity threats or risks associated with flying over conflict zones.

How the EPAS is developed through the safety risk management process?

The EPAS is developed through the European SRM process, which is defined in 5 clear and specific steps as described below.

- **Identification of Safety Issues:** While the identification of safety issues is the first step in the SRM process, because it is a closed loop process the main input comes from the safety performance measurement step at the end of the process. Candidate safety issues are taken from the results of EASA's safety analysis activities as well from the members of the collaborative groups (NoA and the CAGs). The members of these groups are encouraged to raise safety issues that are not currently captured in safety risk portfolios. These candidate safety issues are formally captured by the Agency and are then subject to a preliminary safety assessment. This assessment then informs the decision making process as to whether a candidate safety issue should be included formally within the relevant safety risk portfolio or be subject to other actions. Advice is taken from the NoA and CAGs. The output of this step in the process is the different domain safety risk portfolios. Within the portfolios, both the key risk areas and safety issues are prioritised.

- **Assessment of Safety Issues:** Once a safety issue is identified and captured within the safety risk portfolio, it is subject to a formal safety assessment. These assessments are prioritised within the portfolio. The assessment process is led by EASA and is supported by the NoA and CAGs. These collaborative groups are always involved in the review of each assessment's terms of reference and the results of the assessment. In addition, group members are encouraged to participate in the assessment itself; this external support is vital in achieving the best possible results. The result of the assessment is the production of scenario-based bow tie models that help to identify weak controls for which potential actions can be identified. Together this forms the Safety Issue Assessment (SIA), which provides potential actions for the EPAS. This is followed by the Preliminary Impact Assessment (PIA), which assesses the wider implications and benefits of the proposed actions and makes recommendations on the actions to be implemented in the EPAS.

- **Definition and Programming of Safety Actions:** Using the combined SIA/ PIA, formal EPAS action proposals are then made to the advisory bodies. Once discussed and agreed upon, the actions are then included in the next version of the EPAS. Prior to publication, the EPAS is approved by the EASA Management Board.

- **Implementation and Follow-up:** Once actions are in the EPAS, they are then planned and executed. The main action types used in the EPAS are Focussed Oversight, Research, Rulemaking and Safety Promotion. A number of tasks, especially those related to rulemaking take more than one year hence why the EPAS covers a rolling multiple year timescale.

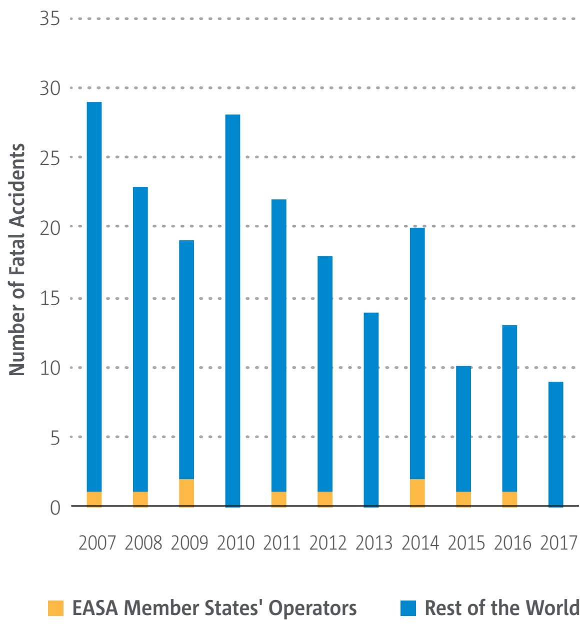
- **Safety Performance Measurement:** Finally, at the end of the process safety performance is measured and monitored. This serves 2 purposes. Firstly, it identifieswhether the actions taken have had the desired impact on safety performance and risk. Secondly, performance monitoring also seeks to identify new risks that had previously not been identified. The main output of this process is this Annual Safety Review

1 Safety Overview

1.1 Global Airline Fatal Accidents

This section covers large aeroplane passenger and cargo operations worldwide. The figures below show the EASA MS operators' contribution to the number of fatal accidents and fatalities at a global level. The relative contribution to the number of fatalities is mainly driven by the size of aircraft and nature of flight (passenger or cargo) involved. In 2017, there were 9 fatal accidents and 67 fatalities worldwide, the lowest number of fatal accidents and fatalities since the start of our records in 1970. There were no fatal accidents involving EASA MS operators.

➨ Figure 1. Number of Fatal Accidents and Fatalities Involving Large Aeroplane Passenger and Cargo Operations, EASA MS and Rest of the World, 2007-2017



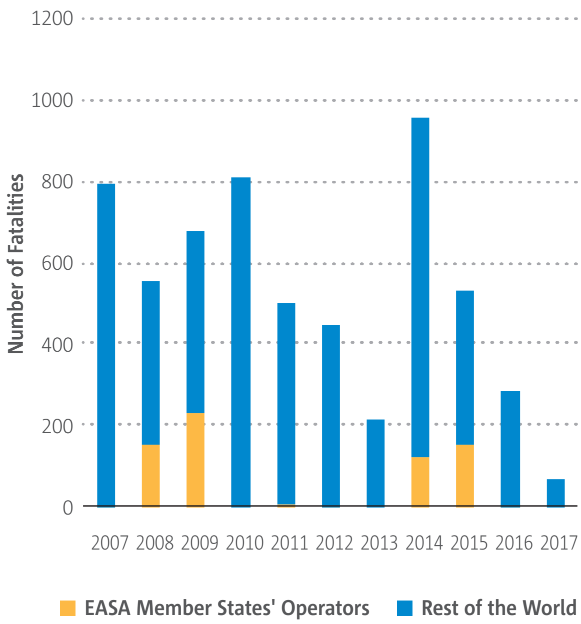
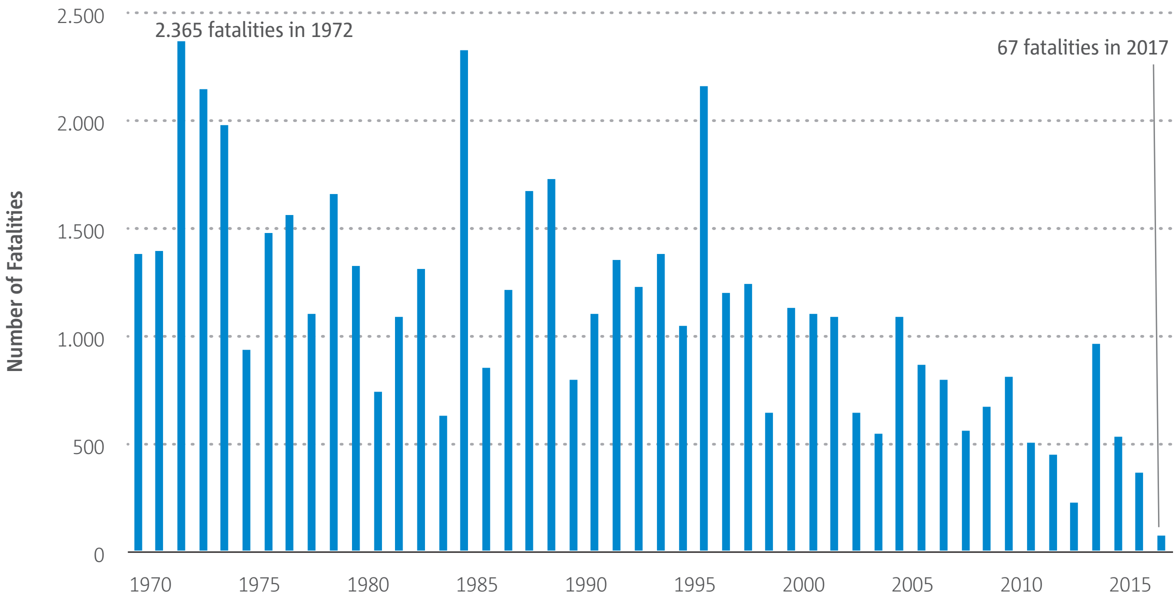


Figure 2. Number of Fatalities Involving Large Aeroplane Passenger and Cargo Operations Worldwide, 1970-2017



One of the reasons that 2017 had a particularly low number of fatalities in comparison with previous years is that the highest number of fatalities in a single accident was 39 and the median number of fatalities was 4 per accident. In comparison, over the previous ten years (2007-2016), the highest number of fatalities in a single accident was 298 and the median was 8.

1.2 EASA Member States Cross Domain Safety Overview

For each domain analysed in this Annual Safety Review, the number of fatal accidents and fatalities for 2017 has been compared with the preceding ten years, 2007-2016. The table reflects the chapter structure and definitions of the Annual Safety Review. For the aircraft chapters (aeroplanes, rotorcraft, balloons, gliders and saiplanes), the definition relates to aircraft operated by an EASA member state AOC holder or registered in an EASA member state.

Both the mean average and the median number of fatalities is shown for the period 2007-2016. This is because for some aircraft domains the median provides a better representation of the number of accidents per year. This is typically related to the number of passengers on board aircraft involved in fatal accidents. Sailplanes usually only have one person on board and the number of fatal accidents and both the mean and median number of fatalities are very similar. By contrast, commercial air transport (CAT) airline accidents may involve one or several hundred fatalities, therefore the annual number of fatalities varies and the mean and median figures are quite different.

It can be seen in Table 1 that the highest number of fatal accidents and fatalities in 2017 occurred in the Non-Commercial Operations (NCO) aeroplane domain. This domain also has the highest mean number of fatal accidents and the highest mean and median number of fatalities over the preceding 10 years. By contrast, there were no fatal accidents in CAT-airlines, Non-commercial Complex (NCC) Business aeroplanes, and Offshore CAT rotorcraft in 2017. Of these domains, over the preceding 10 years the lowest mean number of fatal accidents per year was in CAT-airlines. NCC-business had the lowest number of fatalities over the decade, followed by Offshore CAT helicopters.

➨ Table 1. Cross Domain Comparison of EASA MS Aircraft Fatal Accidents and Fatalities, 2007-2017

Aircraft Domain	Fatal Accidents 2017	Fatal Accidents 2007-2016 Mean	Fatalities 2017	Fatalities Annual 2007-2016 Mean	Fatalities Annual 2007-2016 Median
Aeroplanes					
CAT - Airlines	0	0.9	0	66.4	4.0
NCC - Business	0	0.5	0	0.6	0.0
Specialised operations	3	7.3	4	18.1	16.5
Non-commercial operations	34	50.1	62	92.2	91.0
Rotorcraft					
Offshore CAT	0	4.0	0	3.6	0.0
Onshore CAT	1	1.7	6	5.4	6.0
Specialised operations	3	4.0	4	7.5	6.0
Non-commercial operations	3	10.2	7	18.7	19.0
Balloons	3	5.6	7	13.2	12.5
Sailplanes	25	25.4	27	29.5	29.5

A separate table has been used for aerodromes and ground handling (ADM & GH) and air traffic management/ air navigation services (ATM/ANS), reflecting the fact that the definition here is different: it includes all fatal accidents and fatalities that happened at aerodromes or in airspace in an EASA member state. Therefore the infrastructure table not only counts fatal accidents and fatalities that are already in the table for the aircraft chapters, but also some that involve operators or aircraft registered outside of a member state.

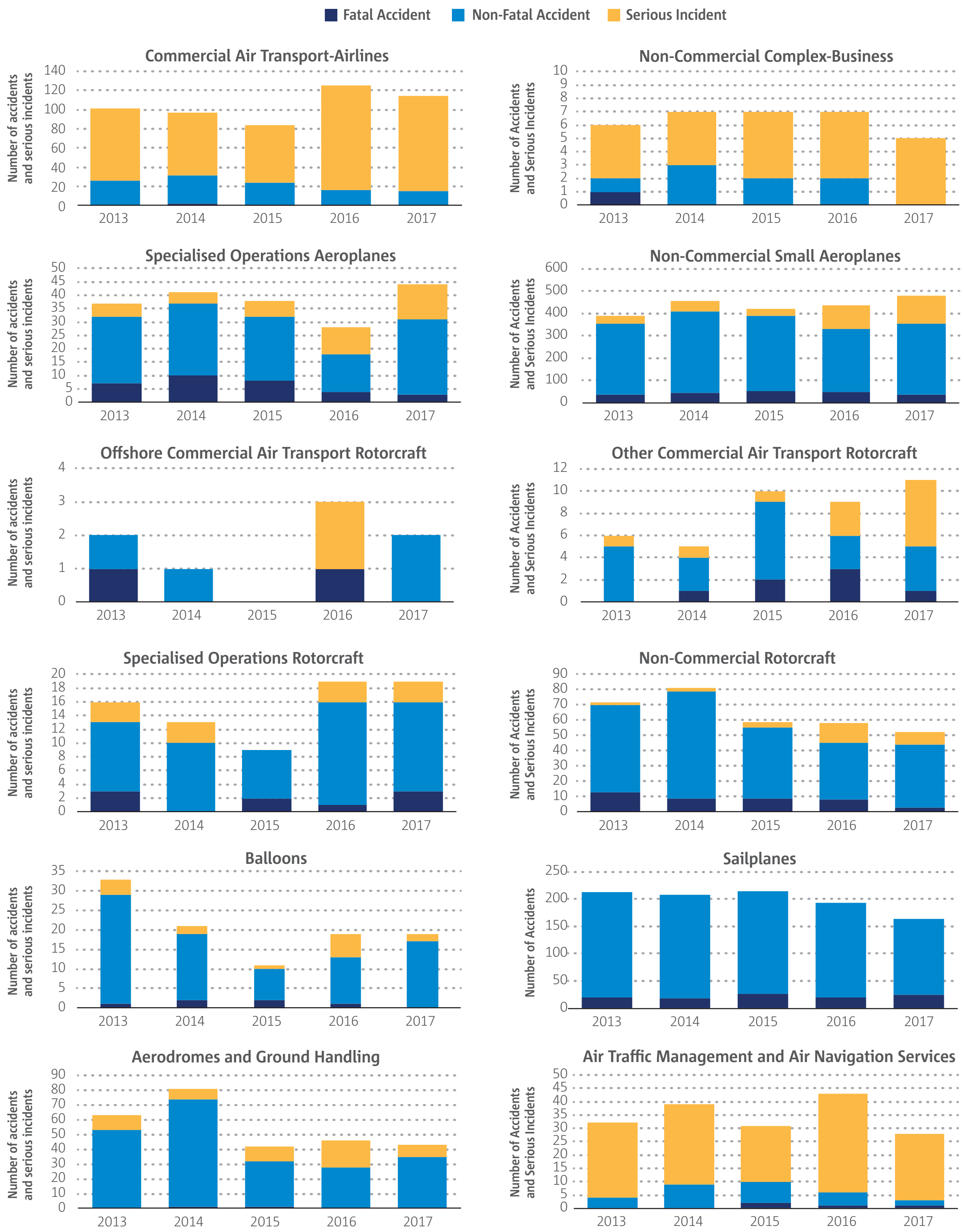
➨ Table 2. Cross Domain Comparison of EASA MS Infrastructure Fatal Accidents and Fatalities, 2007-2017

Infrastructure	Fatal Accidents 2017	Fatal Accidents 2007-2016 Mean	Fatalities 2017	Fatalities Annual 2007-2016 Mean	Fatalities Annual 2007-2016 Median
ADM & GH	0	0.7	0	17	0.5
ATM/ANS*	1	0.5	6	1.6	0

*the ATM/ANS figures include both ATM/ANS related and contribution accidents.

The graphs below show the number of fatal accidents, non-fatal accidents and serious incidents for each aircraft domain, providing a visual comparison.

Figure 3. Number of Fatal Accidents, Non-fatal Accidents and Serious Incidents by Domain, 2013-2017



2 Operations with Aeroplanes

This chapter covers aeroplane operations. The chapter is divided in to two sections:

1. EASA Air Operators (EASA AOC Holders) of airline passenger/cargo with aeroplanes having a maximum take-off weight above 5700 kg
2. EASA MS registered complex aeroplane operating non-commercial operations (NCC) not classified as special operations (SPO) and with a maximum take-off weight above 5700 kg

For each section, the key statistics are presented. A common safety risk portfolio has been developed since, despite the different type of operations, they both have a large amount of commonalities in terms of risk areas and safety issues.

2.1 Commercial Air Transport - Airlines

This section covers the main statistics for the EASA Air Operators (EASA AOC Holders) of airline passenger/cargo with aeroplanes having a maximum take-off weight above 5700 kg. Data is based on the accidents and serious incidents collected by the Agency as per Annex 13 investigations or by the active search of those events from other official sources.

2.1.1 Key Statistics

The key statistics for this domain are in the tables below and include comparison of the number of accidents (fatal and non-fatal) and serious incidents for the 10-year period 2007-2016 and the last year (2017). It also includes the comparison of the fatalities and serious injuries happened in those accidents between the same timeframe.

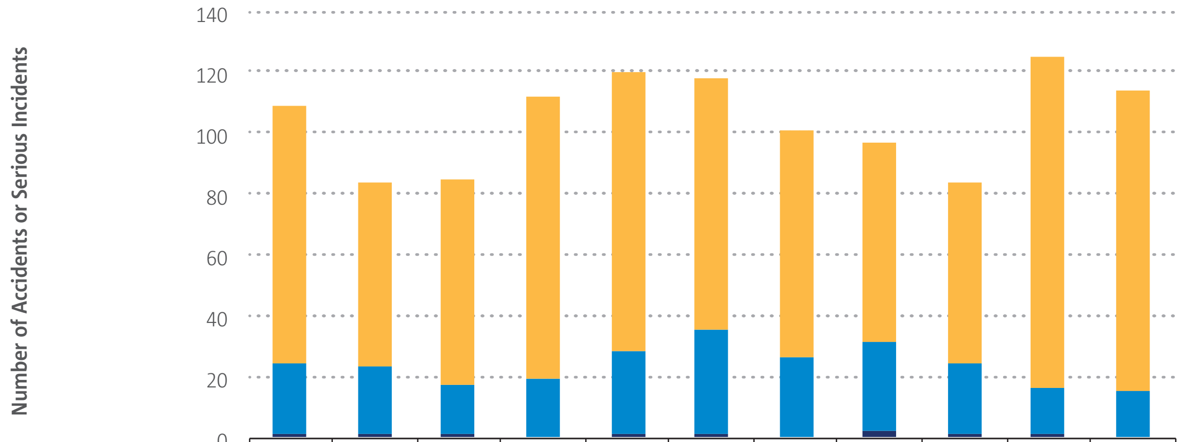
➨ Table 3. Key Statistics for Commercial Air Transport Airlines, 2007-2017

Timespan	Fatal Accidents	Non-Fatal Accidents	Serious Incidents
2007-2016 total	9	235	792
2017	0	15	99

Timespan	Fatalities	Serious Injuries
2007-2016 total	664	111
2017	0	10

During 2017, there were no fatal accidents involving European CAT AOC Holders and the number of non-fatal accidents was lower than the average of the previous 10-year period. In 2017, there was an increase in serious incidents in comparison with the average of the previous 10-year period.

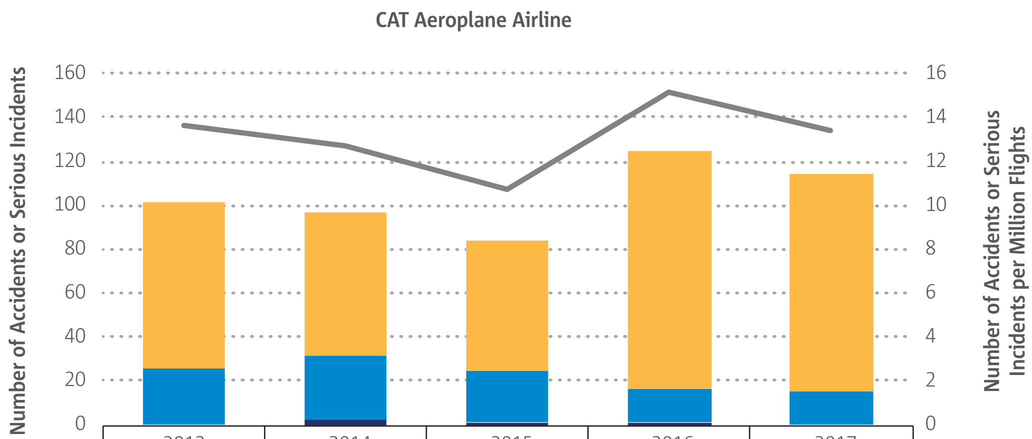
Figure 4. Number of fatal accidents, non-fatal accidents and serious incidents for commercial air transport airlines, 2007 - 2017



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Serious Incident	85	61	68	93	92	83	75	66	60	109	99
Non-Fatal Accident	23	22	16	19	27	34	26	29	23	15	15
Fatal Accident	1	1	1	0	1	1	0	2	1	1	0

The rate of accidents has continued to decrease since 2014, although the number of serious incidents remains higher than usual following a peak in 2016. This peak is the result of the more stringent classification of separation minima infringements by the Members States Aviation and Safety Investigation Authorities, after the entry into force of the Regulation (EU) 376/2014.

Figure 5. Number and rate of fatal accidents, non-fatal accidents and serious incidents for commercial air transport airlines, 2013 - 2017

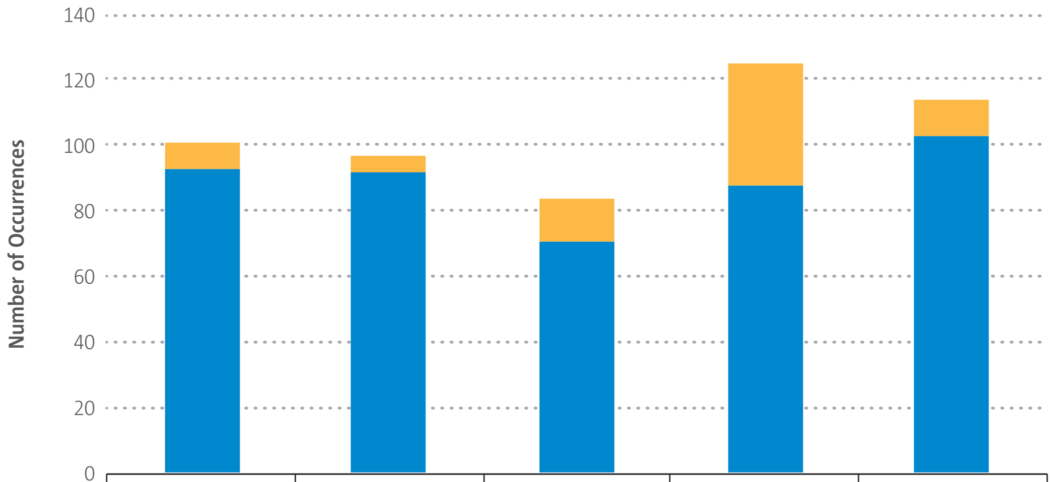


	2013	2014	2015	2016	2017
Serious Incident	75	66	60	109	99
Non-Fatal Accident	26	29	23	15	15
Fatal Accident	0	2	1	1	0
Rate per million flights	14	13	11	15	13

The use of the classification of accidents and serious incidents does not necessarily provide an accurate picture of the risk of those events. As example, a very close near-miss would be classified as a serious incident, while a collision between ground handling vehicle and an aircraft leading to substantial damages of the later would be classified as an accident. It is clear that in terms of risk, the serious incident in this example would be higher than the accident. This is the reason why the Regulation (EU) 376/2014 mandates the development and use of a common European Risk Classification Scheme (ERCS) to risk classify all occurrences reported to the European Authorities. The main purpose of this risk score is to be able to discriminate between the occurrences with a high and lower associated risk. EASA, together with an expert group composed by relevant European Risk Experts, has developed the ERCS methodology that will be published by the European Commission 2018.

Figure 6 shows the intended evolution of the key statistics from the accidents and serious incidents data supporting this section toward higher risk and lower risk occurrences. As it can be seen, the data shows a different pattern than the representation of accidents and serious incidents. This is because of the high risk of the occurrences classified as serious incidents that, in many cases equals or even exceeds the risk of the certain accidents.

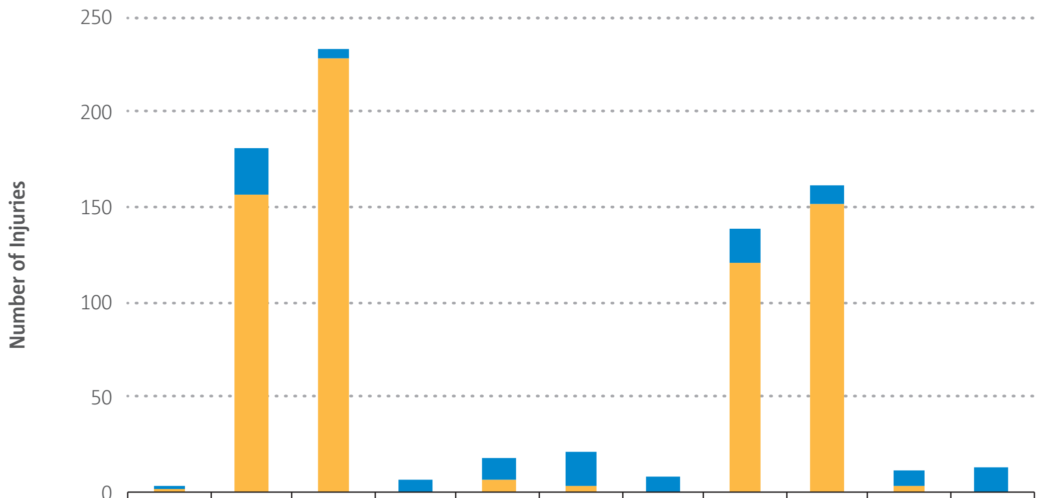
➨ Figure 6. Number of accidents and serious incidents by higher and lower ERCS score for commercial air transport airline operations, 2013 - 2017



	2013	2014	2015	2016	2017
Lower Risk	8	5	13	37	11
Higher Risk	93	92	71	88	103

As can be seen in Figure 7, the number of fatalities per year changes substantially, being dependent on the size and occupancy of the aeroplane that involved in the accident.

➨ Figure 7. Number of fatalities and serious injuries involving commercial air transport airlines, 2007 - 2017

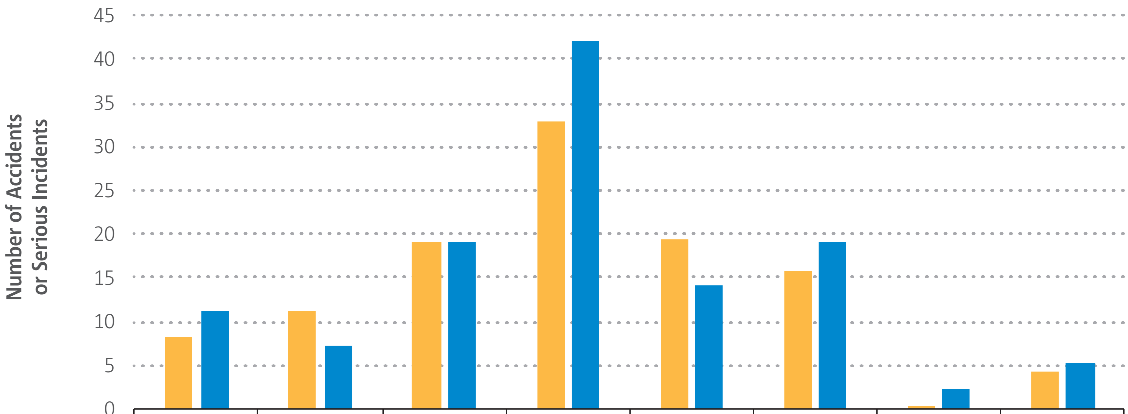


	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Total Serious Injuries	2	25	4	6	11	18	8	18	10	9	12
Total Fatalities	1	155	228	0	6	2	0	120	150	2	0

2.1.1.1 Phase of Flight

The numbers for 2017 show a decrease of accidents and serious incidents in taxi and approach when compared to the 10 year average. In same period however, accidents and serious incidents occurred during the other flight phases have increased. The “Unknown/blank” flight phase corresponds to those occurrences where no data was available and it normally relates to the second aircraft in some of the occurrences (e.g. a general aviation leisure flight leading to a loss of separation with an airliner, missing information on the specific flight phase for the general aviation flight).

➨ Figure 8. Distribution of accidents and serious incidents by flight phase for commercial air transport airlines, 2007 - 2017

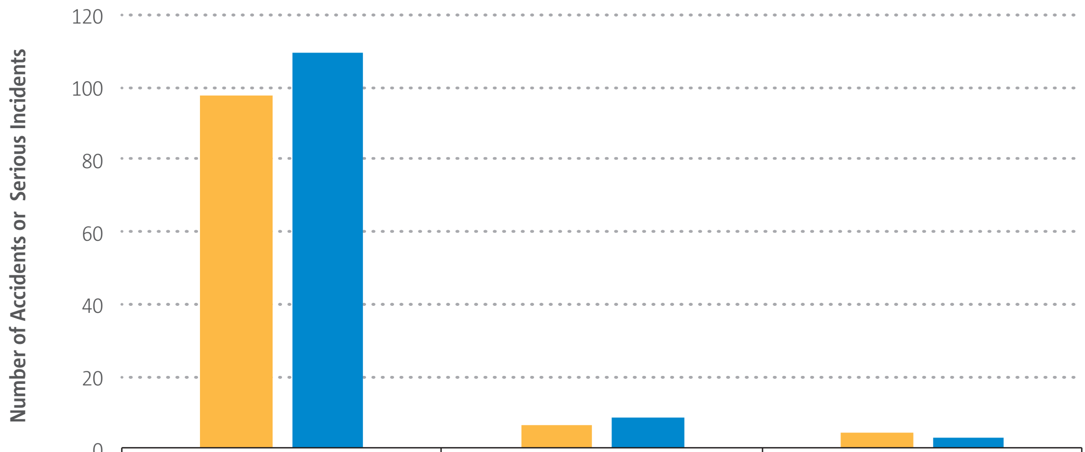


	Standing	Taxi	Take-off	En route	Approach	Landing	Tow	Unknown/ Blank
Average 2007-2016	7.9	11	18.8	32.8	19.1	15.6	0.1	4
2017	11	7	19	42	14	19	2	5

2.1.1.2 Operation Type

The numbers for 2017 show a similar distribution between operation types (passenger or cargo) in comparison to the 10 year average, with a slight increase for the figures in 2017. "Unknown/blank" corresponds to those occurrences where no data on the operation type was available and it normally relates to the second aircraft in some of the occurrences (e.g. loss of separation between an airliner and another aircraft).

➨ Figure 9. Distribution of accidents and serious incidents by operation type for commercial air transport airlines, 2007 - 2017

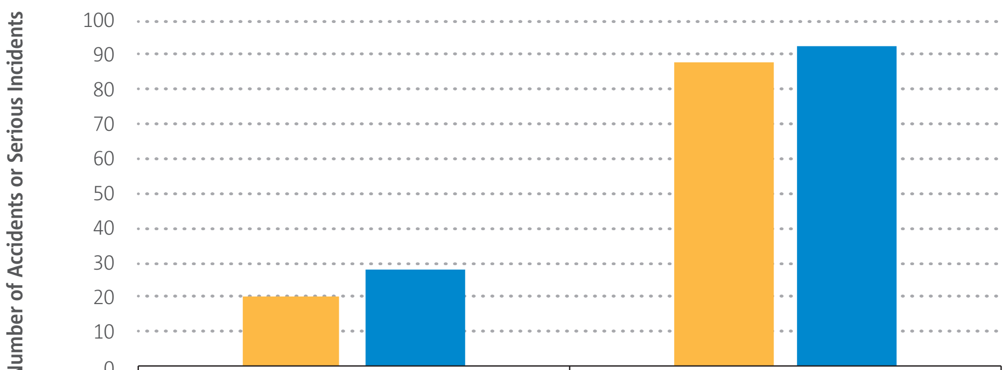


	Passenger	Cargo	Unknown/Blank
Average 2007-2016	97	6	4
2017	109	8	3

2.1.1.3 Propulsion Type

The split by propulsion type shows an increase in 2017 of the turbofan and turboprop related occurrence in reference to the 10 year average. The comparison between turbofan and turboprop is in line with the split of aircraft fleet sizes and its different exposure figures.

➨ Figure 10. Distribution of accidents and serious incidents by propulsion type of the aeroplane(s) involved for commercial air transport airlines, 2007 - 2017



	Turboprop	Turbofan
Average 2007-2016	20.2	87.7
2017	28	92

2.2 Non-Commercial Complex – Business

This section covers the safety performance of the EASA MS registered complex aeroplanes operating non-commercial operations (NCC) not classified as special operations (SPO) and with a maximum take-off weight above 5,700 kg. Data is based on the accidents and serious incidents collected by the Agency as per Annex 13 investigations or by the active search of those events from other official sources.

2.2.1 Key Statistics

The key statistics for this domain are in the tables below and include a comparison of the number of accidents (fatal and non-fatal) and serious incidents for the 10-year period 2007-2016 and the last year (2017). It also includes the comparison of the fatalities and serious injuries happened in those accidents between the same timeframe.

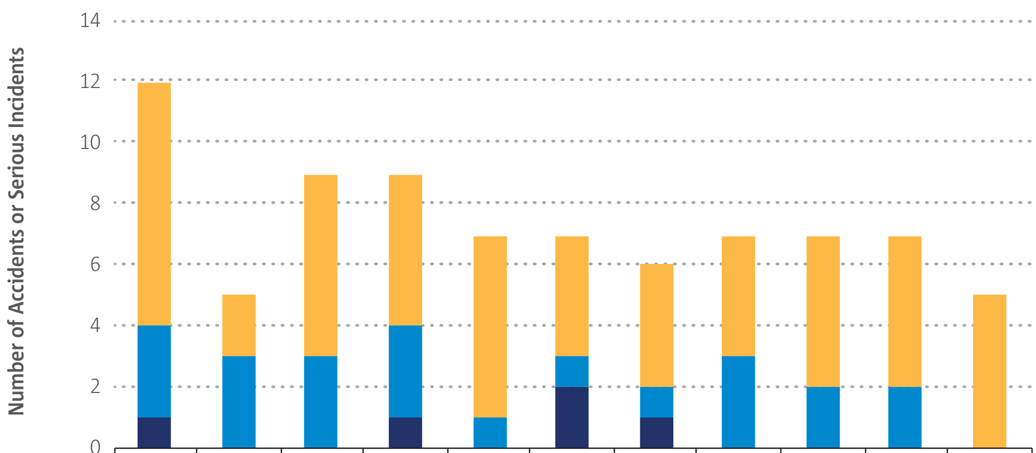
➨ Table 4. Key Statistics for Non-commercial Complex Business Operations, 2007- 2017

Timespan	Fatal Accidents	Non-Fatal Accidents	Serious Incidents
2007-2016 total	5	22	49
2017	0	0	5

Timespan	Fatalities	Serious Injuries
2007-2016 total	6	3
2017	0	0

During 2017, there were no accidents involving European registered NCC operated aircraft, therefore there were also no fatalities or serious injuries in 2017. The number of serious incidents remained as the average of the previous 10-year period. The low numbers probably indicate an incomplete dataset, possibly as a result of the lack of reporting of occurrences not classified as accidents.

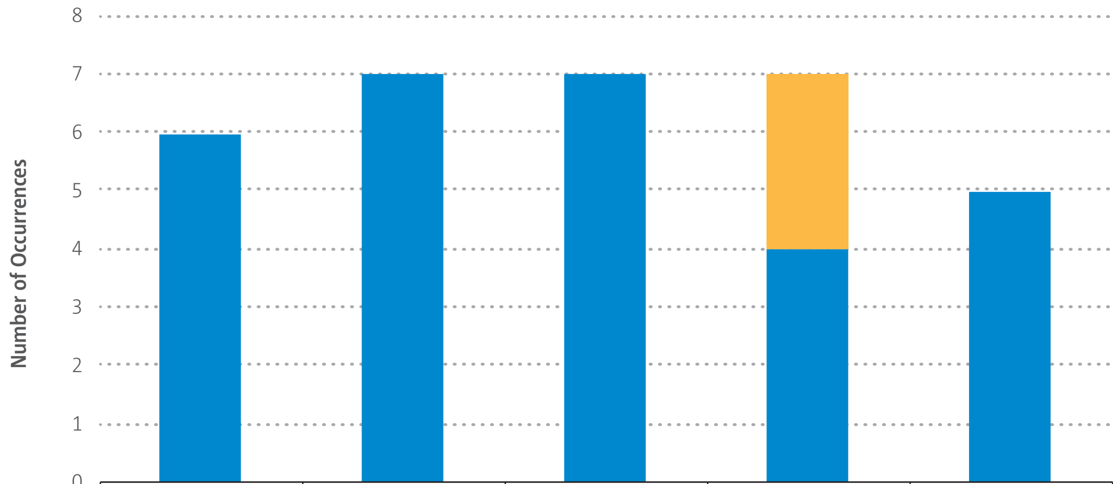
➨ Figure 11. Number of fatal accidents, non-fatal accidents and serious incidents for non-commercial complex business, 2007 - 2017



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Serious Incident	8	2	6	5	6	4	4	4	5	5	5
Non-Fatal Accident	3	3	3	3	1	1	1	3	2	2	0
Fatal Accident	1	0	0	1	0	2	1	0	0	0	0

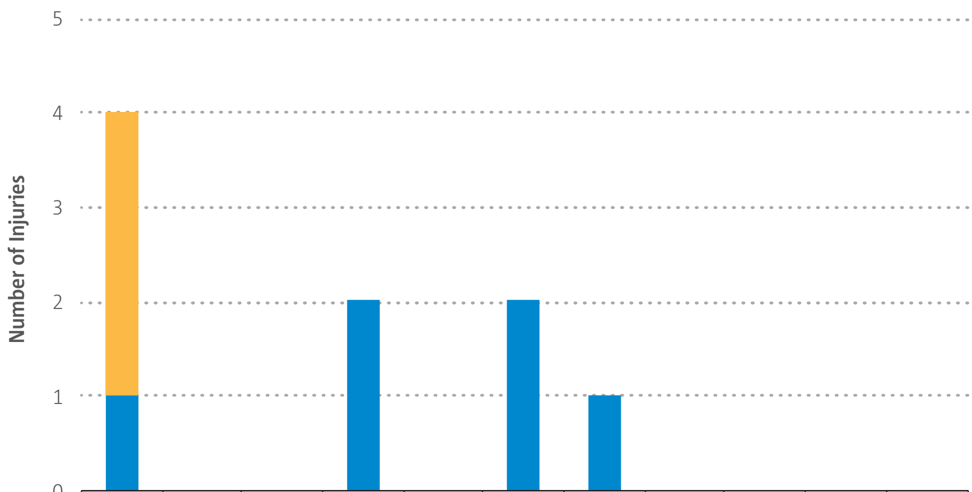
In the same way as in the previous section, Figure 12 shows the split of the accidents or serious incidents by the ERCS score grouped by higher risk and lower risk. This indicator provides an additional view with a proxy to the risk of those occurrences.

Figure 12. Number of accidents and serious incidents by higher and lower ERCS score for non-commercial complex business, 2013 - 2017



	2013	2014	2015	2016	2017
Lower Risk	0	0	0	3	0
High Risk	6	7	7	4	5

Figure 13. Number of fatalities and serious injuries involving non-commercial complex business, 2007 - 2017



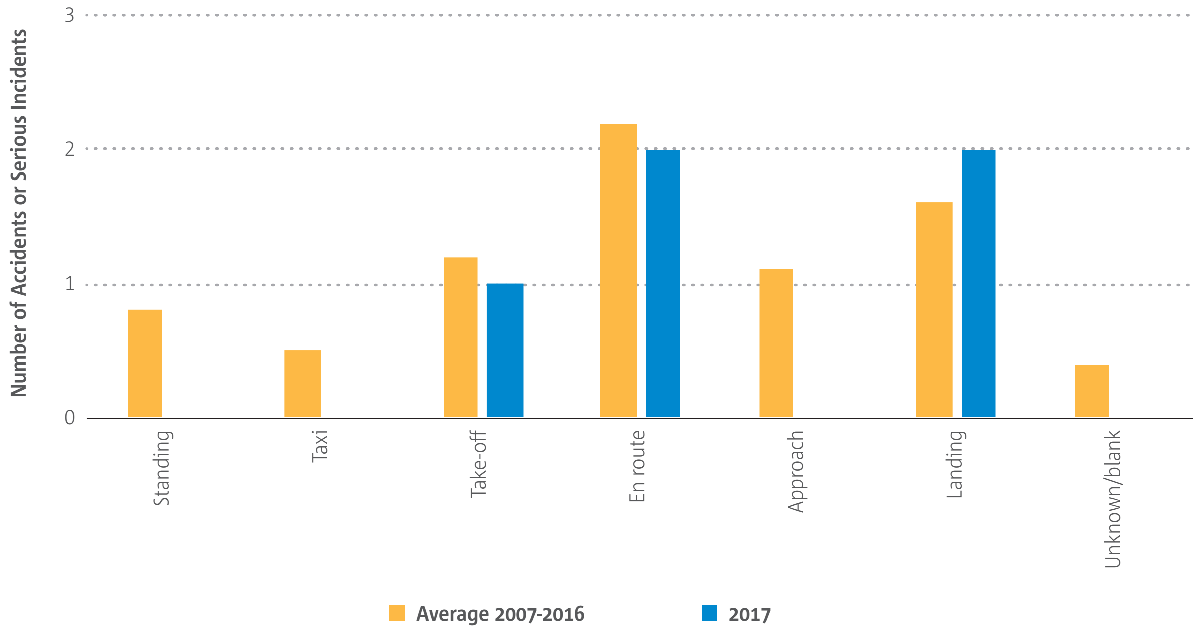
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Total Seriuos Injuries	3	0	0	0	0	0	0	0	0	0	0
Total Fatalities	1	0	0	2	0	2	1	0	0	0	0

Due to the size of the aeroplanes used for the majority of this type of operation, the number of fatalities is significantly low.

2.2.1.1 Phase of Flight

The low numbers in this section prevent any conclusions to be drawn in terms of the flight phase.

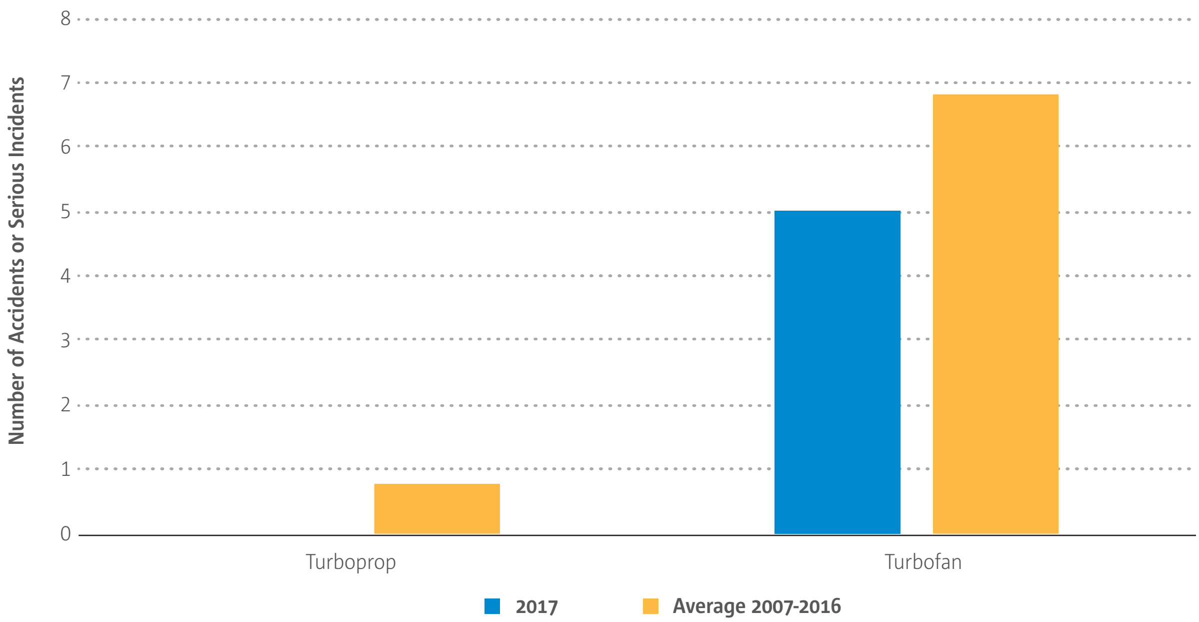
Figure 14. Distribution of accidents and serious incidents by flight phase for non-commercial complex business, 2007 - 2017



2.2.1.2 Propulsion Type

The split by propulsion type shows that the only propulsion type involved in accidents or serious incidents in 2017 was the turbofan type.

Figure 15. Distribution of accidents and serious incidents by propulsion type for non-commercial complex business, 2007 - 2017



2.3 Safety Risk Portfolio for Large Aeroplane (CAT-Airlines and NCC-Business)

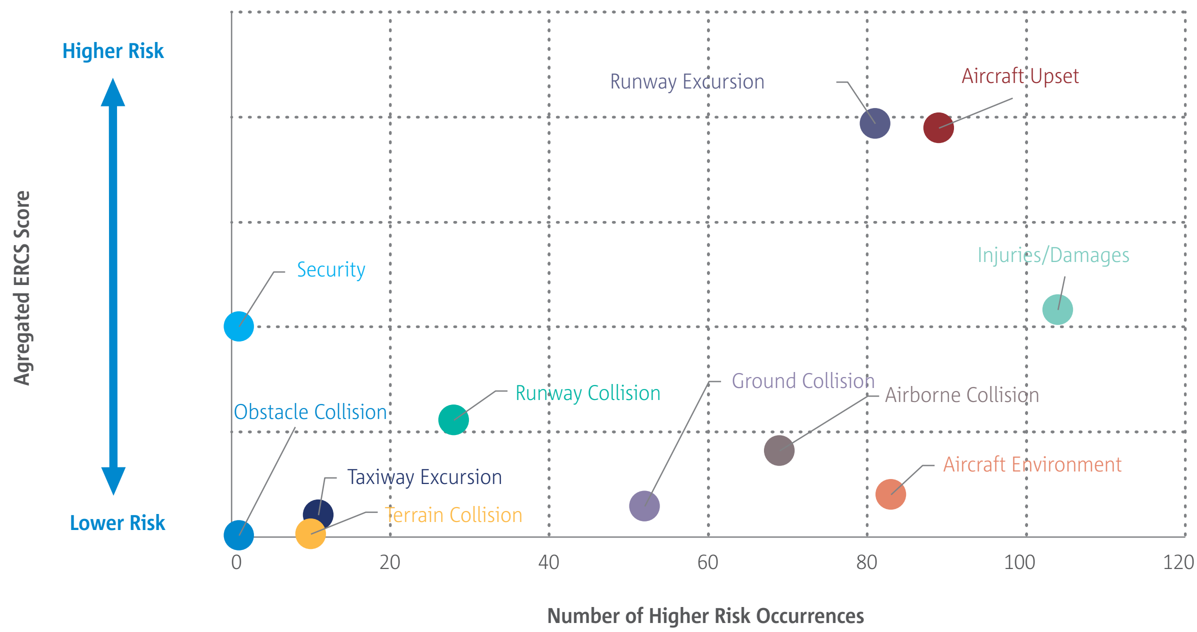
CAT Airlines and NCC Business operations are covered by a single Safety Risk Portfolio due to the similarity of the main risk areas and safety issues for both operation types, and to the small dataset available for NCC-Business. Those safety issues which might be only relevant for one of the operation types are highlighted as such when necessary.

The safety risk portfolio for Airline and NCC-business operation provides a summary of the top risk areas and safety issues of this part of the aviation system. It covers the Key Risk Areas and Safety Issues of the performance framework in each domain. The portfolio is used to prioritise the assessment of safety issues, to target analysis activities over key risk areas and to prioritise safety actions.

While the information presented in the risk portfolio is relevant and provides an indication of the potential areas of concern, it is not yet an indication of main risk areas or safety issues safety wise. This portfolio is used to identify a reduced number of key risk areas on which an in-depth analysis will be carried out to determine the completeness of the safety issues that contribute to those risk areas. It assesses the level of control of the aviation system over the most relevant safety issues. Over the coming months, this assessment will consider the change in exposure to the relevant hazard, the effectiveness of existing controls and the expected risk reduction by committed safety actions. This analysis integrates the expertise from the CAGs and the EASA Operational Departments to complement the view provided by occurrence data.

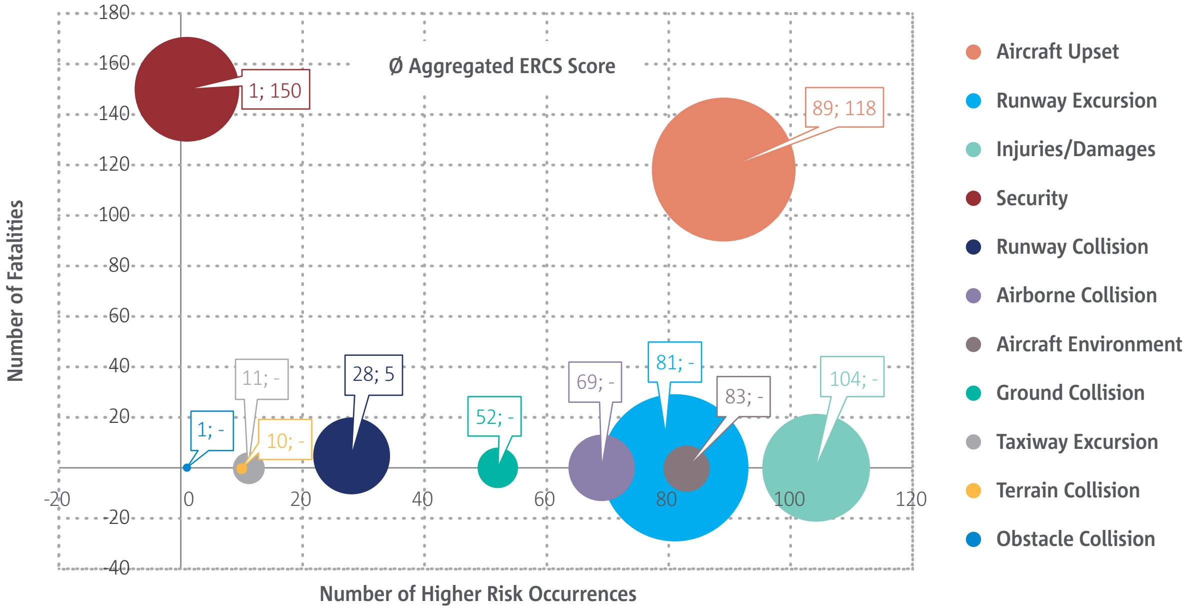
The risk portfolio uses the aggregated ERCS score to provide an initial ranking of the key risk areas and safety issues. The figure below plots the high risk occurrences, based on its ERCS risk score, by their associated key-risk areas. It draws in the x-axis the number of those high risk occurrences per key risk area and in the y-axis the aggregated ERCS risk score for each key risk area.

➨ Figure 16. Distribution of key risk areas by frequency and aggregated ERCS risk score for commercial air transport airlines and non-commercial complex business, 2013-2017



The figure below provides a similar representation of the key risk areas but it introduces the dimension of fatalities associated to them (y-axis) and shows the aggregated ERCS risk score as the size of the bubbles.

➨ Figure 17. Distribution of key risk areas by fatalities, number of higher risk occurrences and ERCS risk score for commercial air transport airlines and non-commercial complex business, 2013-2017



From these two representations, it can be concluded that the key risk areas accumulating higher risk score, based on the occurrence data used, are Runway Excursion and Aircraft Upset. They concern a high number of high risk occurrences and aggregating the highest risk score. At a second stage, it lays the key risk areas of Injuries/Damage and Security. The former occurs often leads to high severity outcomes though to a reduced number of persons (injuries to few crew or passengers). The latter, Security, very much depends on the will and capability to cause harm, considerations not appearing in pure safety risk assessments. Security shows that, while high risk occurrences associated to it are infrequent (only one confirmed in the last 5 years), it becomes of high risk due to the lack of efficient barriers to stop it. Runway Collision and Airborne Collision can be considered at a third stage of importance.

The data portfolio shown in Figure 18 has been sorted following the risk order given by the aggregated ERCS risk score of the high risk occurrences related to key risk areas or to safety issues. It is acknowledged that this indicator is still a proxy to the risk, but it is evaluated as a better reference than the pure sorting by the number of accidents and serious incidents. This indicator will be complemented by the qualitative analysis to estimate the actual risk by considering the increase/reduction of exposure to the relevant hazards and the expected risk reduction of the ongoing safety actions, for both key risk areas and safety issues. This analysis will still provide a proxy to the risk but it will provide a more consistent ranking.

The safety risk portfolio shows in the upper part, the key risk areas (based on the ERCS score) for the past 5 years. A key risk area includes both the undesired outcome (accident) and the immediate precursors to those outcomes (less severe occurrences, normally). In rows, the safety risk portfolio shows a similar spread by safety issues based on the aggregated ERCS score of those occurrences where those safety issue were present. The dotted grid establishes the relation between safety issues and key risk areas – it identifies which safety issues contribute to which (potential) accident outcomes. Dots come from occurrence data.

Based on the data supporting the portfolio, the following relations between the priority 1 key risk areas and safety issues can be highlighted:

- Aircraft Upset:
  - Monitoring of flight parameters and automation modes
  - Approach path management
  - Convective weather
  - In flight icing
  - Handling of technical failures
- Runway Excursion
  - Approach path management
  - Monitoring of flight parameters and automation modes
  - Handling of technical failures

The main Key Risk Areas highlighted above are defined by their accident outcome to be prevented and by the immendiate precursors of that accident outcome.

- **Aircraft upset:** Includes uncontrolled collisions with terrain following an aircraft upset, but also occurrences where the aircraft deviated from the intended flight path or intended flight parameters, regardless of whether the flight crew realised the deviation and whether it was possible to recover or not. It also includes the triggering of stall warning and envelope protections.

- **Runway excursion:** Covers actual runway excursions, both at high and low speed, and occurrences where the flight crew had difficulties maintaining the directional control of the aircraft or of the braking action during landing, where the landing occurred long, fast, off-centred or hard, or where the aircraft had technical problems with the landing gear (not locked, not extended or collapsed) during landing.

The safety issues identified as the main contributors and highlighted above are defined as follows:

- **Monitoring of flight parameters and automation modes:** The inadequate monitoring of the main flight parameters and automation modes, potentially leading to the upset of the aircraft, runway excursion or controlled collision with terrain. It covers the relevant Standard Operating Procedures (SOPs) and trainings of the flight crew. It also includes the considerations related to human factors, especially to the human-machine interface (HMI) of aircraft systems and indications.

- **Approach path management:** Ineffective or incorrect management of the approach path (that is not stable and/or compliant) that may lead to go-arounds, hard landings or runway excursion.

- **Convective weather:** It is the situation where the aeroplane flies within atmospheric convective phenomena, potentially leading to aircraft upset (uncontrolled collision with terrain) and injuries to passengers or crew. The safety issue covers the main convective phenomena affecting safe flight, such as convective turbulence, up/down-drafts, wind shear, hail precipitation, lightning and icing. The main threat posed by this safety issue is the loss of control of the aircraft after being forced out of its flight envelope by a severe atmospheric phenomenon or after a system failure not adequately handled by the flight crew. This safety issue may also lead to injuries mainly due to the sudden encounter with turbulence. The safety issue covers the detection, avoidance and flying in convective weather during the flight, and all the support to flight crews to deal with it before (such as flight planning, meteorological information) and during the flight (e.g. on-board detection systems, ATS vectoring). It especially covers the SOPs and training of the flight crew to maintain or recovering the safe flight. The safety issue also considers the robustness of the aeroplane to conduct a flight in convective atmospheric conditions, as per its initial certification and its in-service experience (that is the continuous airworthiness process).

- **In flight icing:** The situation where the aeroplane flies within icing conditions, potentially leading to aircraft upset (uncontrolled collision with terrain) due to ice accretion on the aeroplane. The main threat posed by this safety issue is the contamination of aircraft surfaces or systems that may severely impact the performance or controllability of the aircraft. It covers the detection, avoidance and flying-in icing conditions during the flight, and all the support to flight crew to deal with it before (that is flight planning, meteorological information) and during the flight (e.g. on-board detection systems, de/anti-icing systems). It especially covers the SOPs and training of the flight crew to maintain or recovering the safe flight. The safety issue also considers the robustness of the aeroplane to conduct a flight in icing conditions, as per its initial certification and its in-service experience (i.e. continuous airworthiness process). This safety issue partially overlaps with the Convective Weather safety issue.

- **Handling of technical failures:** The ineffective handling of a non-catastrophic technical failure by the flight crew. Technical failures are those not rendering the aircraft uncontrollable and for which the flight crew are trained to manage them. It includes the human factors playing a role in the realisation and processing of the failure information and the later reaction of the crew to handle the issue. It covers the related SOP and trainings of the flight crew.

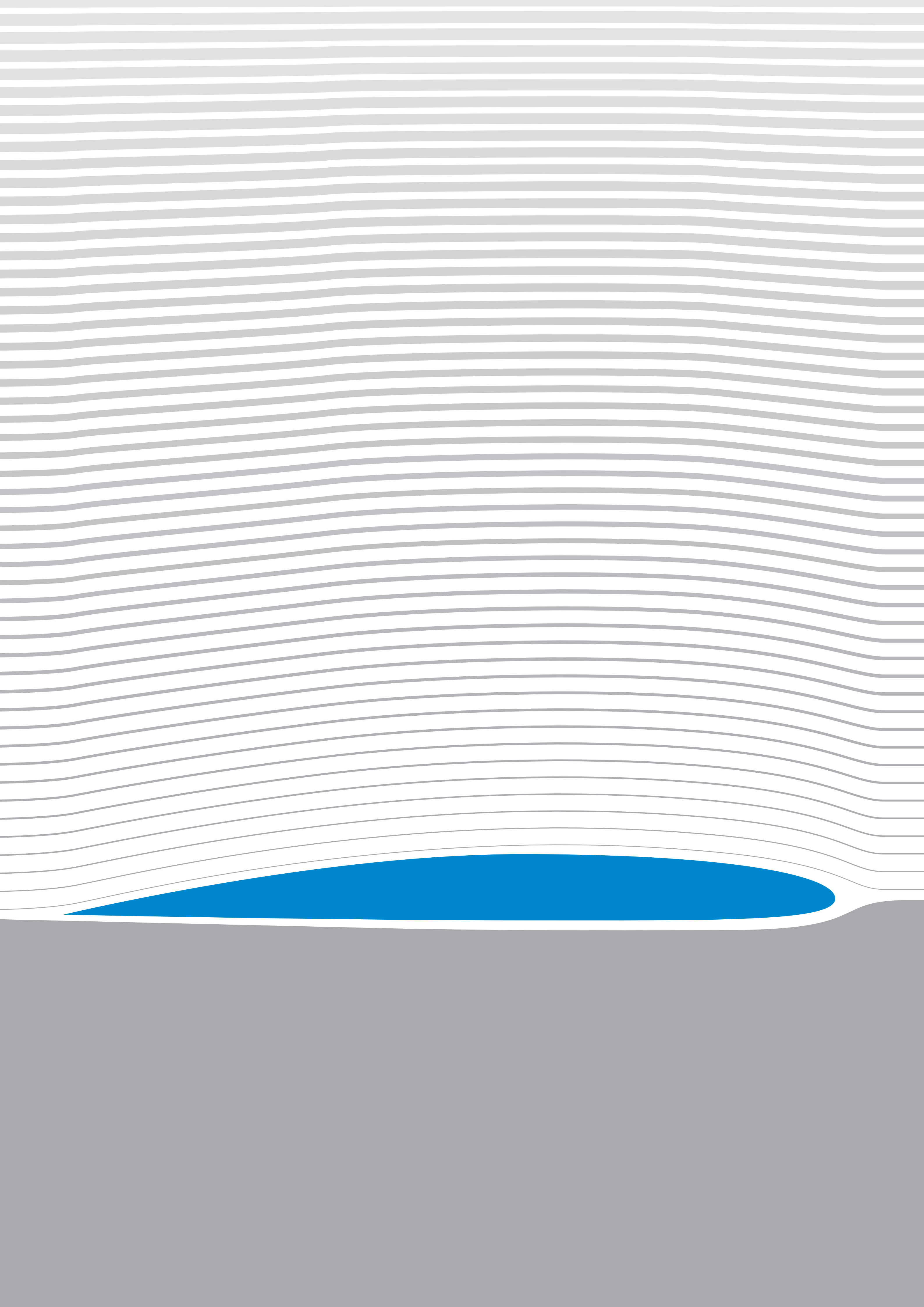
Figure 18. Safety Risk Portfolio for CAT Airline and NCC Business aeroplane operations showing how the 5-year occurrence data 2013-2017 relates to safety issues and their outcomes relative to risk in descending order.

Large Aeroplane - Airlines / NCC Business												
Bands of Aggregated ERCS Risk Score (2013-2017)		Priority 1		Priority 2		Priority 3		Priority 4				
High Risk ERCS Occurrences (2013-2017)		89	81	104	1	28	69	83	52	11	10	1
Safety Issues	Bands of Aggregated ERCS Score 2013-2017	Key Risk Areas (Outcomes and precursors)										
		Aircraft Upset	Runway Excursion	Injuries/Damages	Security	Runway Collision	Airborne Collision	Aircraft Environment	Ground Collision	Taxiway Excursion	Terrain Collision	Obstacle Collision
Perception and Situational Awareness		●	•	•		●	●	•	●	•	•	•
Monitoring of Flight Parameters and Automation Modes		●	●	•			•	•			•	
Approach Path Management		●	●	●		•	•				●	•
Convective Weather (Turbulence, Hail, Lightning, ice)		●	•	●			•				•	
Icing in Flight		●		•								
Mental Health					•							
Handling of Technical Failures		●	●	●			•	●		•	•	
CRM and Operational Communication		●	•	•		•	•	•	•			
Braking and Steering			●	●				•	•	●		
Flight Planning and Preparation		●	●	•			•	•	•			
Experience, Training and Competence of Individuals		•	•	•		•			•			
Runway Surface Condition			●	•								
Crosswind		•	•	•		•					•	•
Deconfliction with Aircraft Not Using Transponders							●					
ACAS RA Not Followed							•					
Inappropriate flight control inputs		•	•	•			•					
Taxi Speed and Directional Control			•						•	●		
Knowledge of Aircraft Systems and Procedures		●	•	•				•				
Alignment with wrong runway		•	•	•		•			•	•	•	•
Fatigue			•	•								
Wake Vortex		•					•					

● **A significant number of occurrences** • **A small number of occurrences**

Large Aeroplane - Airlines / NCC Business												
Bands of Aggregated ERCS Risk Score (2013-2017)		Priority 1		Priority 2		Priority 3		Priority 4				
High Risk ERCS Occurrences (2013-2017)		89	81	104	1	28	69	83	52	11	10	1
Safety Issues	Bands of Aggregated ERCS Score 2013-2017	Key Risk Areas (Outcomes and precursors)										
		Aircraft Upset	Runway Excursion	Injuries/Damages	Security	Runway Collision	Airborne Collision	Aircraft Environment	Ground Collision	Taxiway Excursion	Terrain Collision	Obstacle Collision
Clear Air Turbulence (CAT) and Montain Waves		•		●								
Entry of Aircraft Performance Data		●	●						•			
Fumes Effects		•		•				●				
Aircraft maintenance		●	•	•				●			•	
Decision Making and Planning		•	•	•					•		•	
Icing on Ground		•	•	•				•	•			
Slow Rotation at Take-off		•	•									
Airborne Separation RPAS							•					
Windshear		•	•				•					
Baggage and Cargo loading		•										
False or Disrupted ILS Signal Capture		•	•			•					•	•
Gastrointestinal Illness				•								
Transport of Lithium Batteries				•				•				
Handling and Execution of Go-Arounds		•					•	•			•	
Bird/ Wildlife Strikes		•										
Personal Pressure and Arousal		•	•									
Supporting Information to the Flight Crews												
Tyre pressure condition												
Disruptive Passengers												
Effectiveness of Safety Management												
Fuel Contamination		under evaluation										
Laser Illumination Effects		under evaluation										
Fuel Management		under evaluation										
Non-Precision Approaches		under evaluation										
Safety Culture		under evaluation										
Damage Tolerance to UAS Collisions		under evaluation										

● **A significant number of occurrences** • **A small number of occurrences**



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