LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG
Ministère du Développement durable
et des Infrastructures

Direction de l'aviation civile

Direction de l'aviation civile

Annual Safety Review 2016

1. Introduction

The mission of the Directorate of Civil Aviation Luxembourg (DAC) is to maintain or improve aviation safety, in compliance with national and international regulations.

The objective of this annual safety review is to summarise and analyse the current situation of aviation safety in Luxembourg.

Concerning the analysis of safety occurrences, the year 2016 is a transition year due to the introduction of a new European regulation on occurrence reporting[1]. The new regulation clarified which occurrences are mandatory to report while also promoting voluntary reporting. It reinforced the role of the Safety Management Systems (SMS) of operators of the aviation industry in the collection and analysis of their own reports. In addition to the initial notification, DAC now receives in most cases the classification, risk assessment and follow-up actions performed by the operators. As the operators usually have more detailed information than DAC, the classification and risk assessment may differ from those applied by DAC in the previous years, so that a direct comparison of 2016 data to the previous years is difficult. The new regulation also required a software change for the national occurrence database managed by DAC, which further complicated the analysis of the data.

1 REGULATION (EU) No 376/2014 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 3 April 2014 on the reporting, analysis and follow-up of occurrences in civil aviation, amending Regulation (EU) No 996/2010 of the European Parliament and of the Council and repealing Directive 2003/42/EC of the European Parliament and of the Council and Commission Regulations (EC) No 1321/2007 and (EC) No 1330/2007

2. Accidents and serious incidents

Two accidents and no serious incidents involved civil aircraft registered in Luxembourg in 2016, with no fatalities or injuries. No accidents or serious incidents happened in Luxembourg.

Aircraft category	Date	Location	Event	Outcome	Investigation
Homebuilt	22.6. 2016	LFSE Epinal-Dogneville	Runway overrun during aborted take-off	Significant damage to aircraft	none
Microlight	29.10. 2016	EDRG Idar-Oberstein	Lost part of the wing in flight	Aircraft destroyed	BFU (D), ongoing

The microlight pilot (alone on board) who lost a part of the wing was saved by the fact that his aircraft was equipped with a whole-airplane parachute, which he managed to activate.

A Luxembourg-based aerial work operator suffered an accident with 5 fatalities after take-off in Luqa (Malta) on Oct. 24, 2016. The authorities of Malta, responsible for the investigation, consider the accident flight to be a military operation. Consequently, it is not considered an accident in civil aviation and a military accident investigation has been initiated.

If this fatal accident is excluded, the number and severity of accidents and serious incidents has decreased compared to the previous years. However, due to the very low numbers involved, a year-to-year comparison is not really meaningful.

The definitions of accident, incident and serious incident are given in Annex I.

3. Occurrences

The DAC receives, classifies and analyses occurrence reports. The reports cover events in Luxembourg's airspace and airfields, as well as any events involving air operators from Luxembourg outside of the national territory.

The number of reported occurrences in 2016 has increased by 6% compared to 2015. For the first time, more than 2000 occurrences have been reported to DAC in one year. The number of reports received is even higher, because where two or more persons or organisations reported the same event, the reports have been merged and counted as one occurrence.

Compared to previous years, the distribution among the occurrence classes has changed. 51% more occurrences are classified as "incident", with a corresponding decrease in the classes "observation" and "occurrence without safety effect". The reason for the different distribution is most likely the fact the classification is now made by the reporting organisations whereas it was previously made by DAC.

Occurrence class	2012	2013	2014	2015	**2016**	**Variation 2015-2016**
Observation	332	561	454	535	**470**	***-12%***
Occurrence without Safety Effect	684	813	727	798	**689**	***-14%***
Incident	458	523	597	578	**873**	***+51%***
Serious Incident	3	1	1	3	**0**	
Accident	2	9	5	3	**2**	
Total	1479	1907	1784	1917	**2034**	***+6%***

4. Occurrence categories

All occurrences have been attributed to one or more occurrence categories, as defined by the CICTT[2]. The most frequent occurrence categories are shown in Chart No.1.

2 CAST/ICAO Common Taxonomy Team

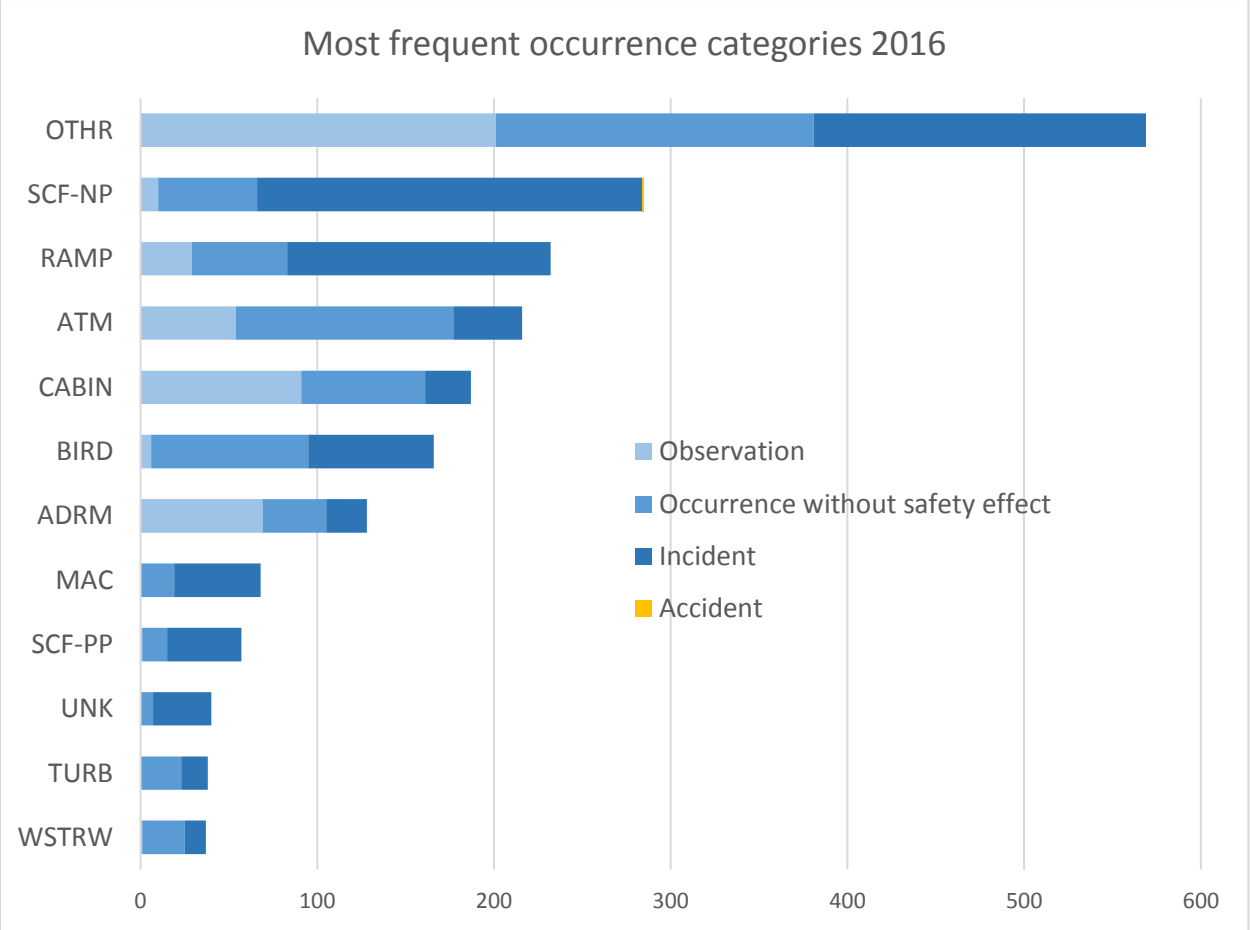


Chart No.1: Most frequent occurrences of 2016, by category

Description of categories:

OTHR:	Any occurrence not covered under another category
SCF-NP:	Failure or malfunction of an aircraft system or component - other than the powerplant
RAMP:	Occurrences during (or as a result of) ground handling operations
ATM:	Occurrences involving Air traffic management (ATM) or communications, navigation, or surveillance (CNS) service issues
CABIN:	Miscellaneous occurrences in the passenger cabin of transport category aircraft
BIRD:	Occurrences involving collisions / near collisions with bird(s)
ADRM:	Occurrences involving aerodrome design, service, or functionality issues
MAC:	Airprox, ACAS alerts, loss of separation as well as near collisions or collisions between aircraft in flight
SCF-PP:	Failure or malfunction of an aircraft system or component - related to the powerplant
UNK:	Unknown or undetermined
TURB:	In-flight turbulence encounter
WSTRW:	Flight into windshear or thunderstorm

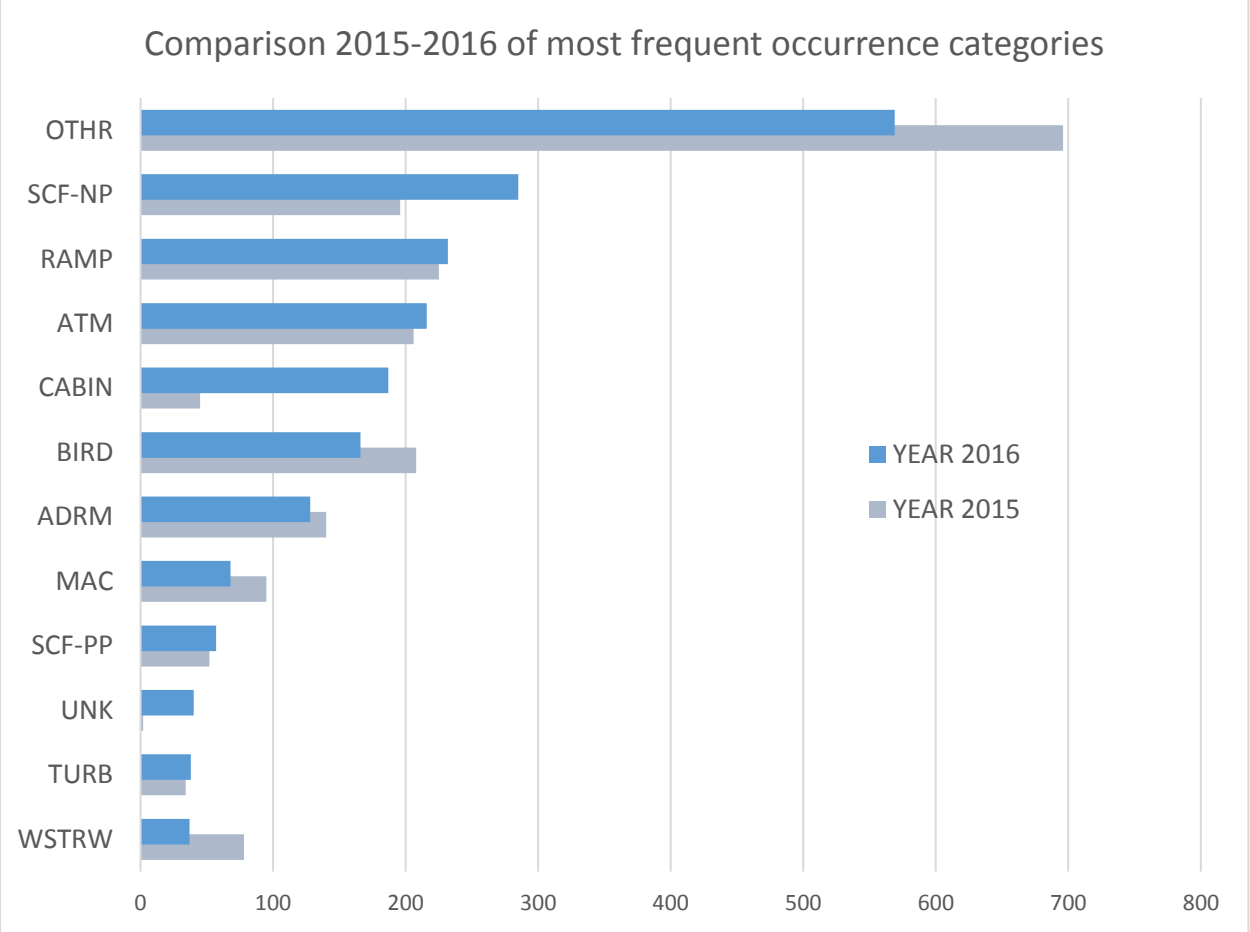


Chart No.2: Comparison of most frequent occurrences of 2016 vs. 2015, by category

In comparison to the occurrence numbers of 2015, a significant increase is noted for the SCF-NP category and for the CABIN category. In both cases it can be assumed that the numbers reflect better reporting rather than an increase in real occurrences. In 2016 DAC did receive more reports originating from maintenance departments (SCF-NP) and from cabin crew (CABIN) than before. Technical occurrences were classified as "incident" in the majority of cases, so that SCF-NP has the highest number of incidents, followed by "OTHR" and "RAMP".

Two of these most frequent categories show clear seasonal trends. While it is expected that the number of birdstrikes (BIRD) increases during the summer, the number of occurrences with a risk of collision between aircraft (MAC) does also increase during the spring and summer. Overall, the number of MAC occurrences shows a decreasing trend.

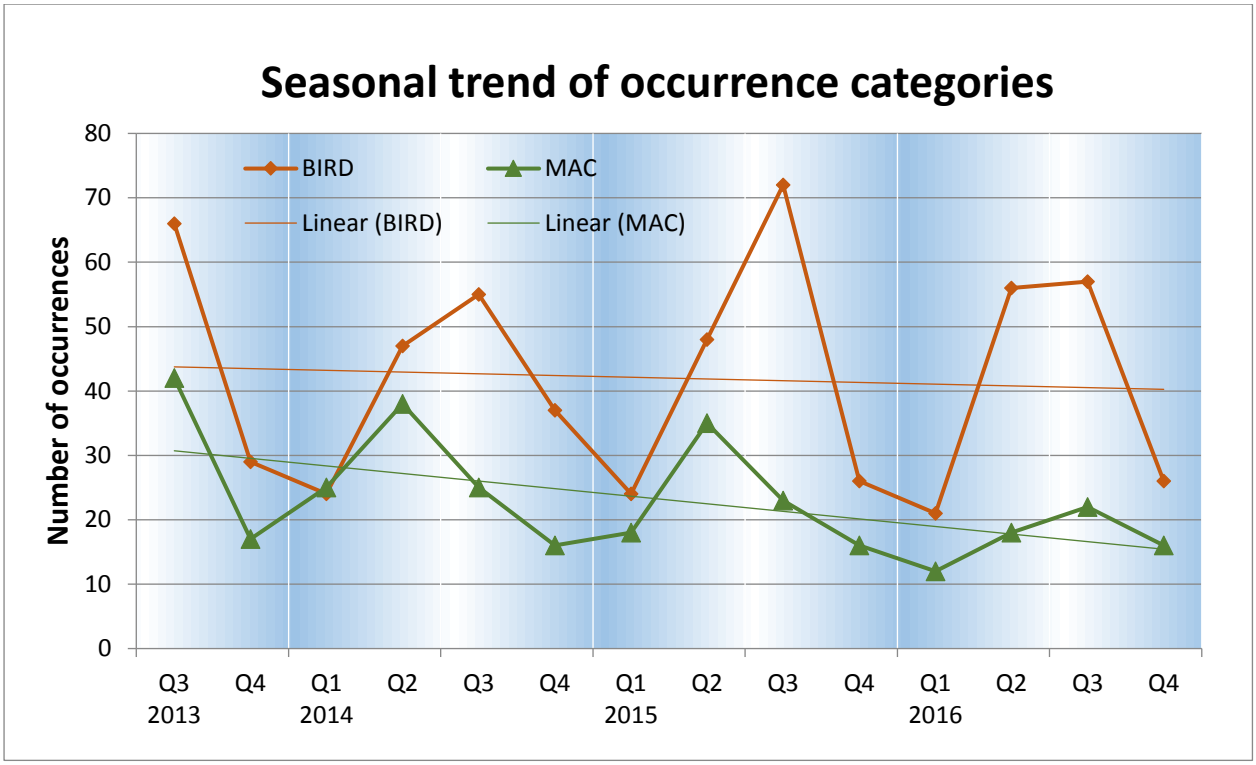


Chart No. 3 : MAC and BIRD occurrences per quarter, since Q3-2013 (occurrence category "observation" excluded)

The DAC is applying the ARMS Risk assessment methodology, which assigns an "ERC Risk Index" to each occurrence (see Annex II for a summary of the ARMS methodology). This allows a comparison of the different CICTT occurrence categories not only by number of occurrences, but also according to the sum of the related ERC Risk Indexes.

Chart No. 4 represents the average of the Risk index per occurrence vs. the number of occurrences, for the 15 CICTT occurrence categories with the highest sum of ERC Risk Indexes. Logarithmic scales have been used due to the large differences between the low and high ends on both scales. The chart shows that category RAMP has the highest overall risk, having both a high number of occurrences and a high average ERC Risk Index, followed by the categories SCF-NP, OTHR and with some distance, MAC. The highest average ERC Risk Index per occurrence, but with a low number of occurrences, is recorded for runway incursions (RI-VAP).

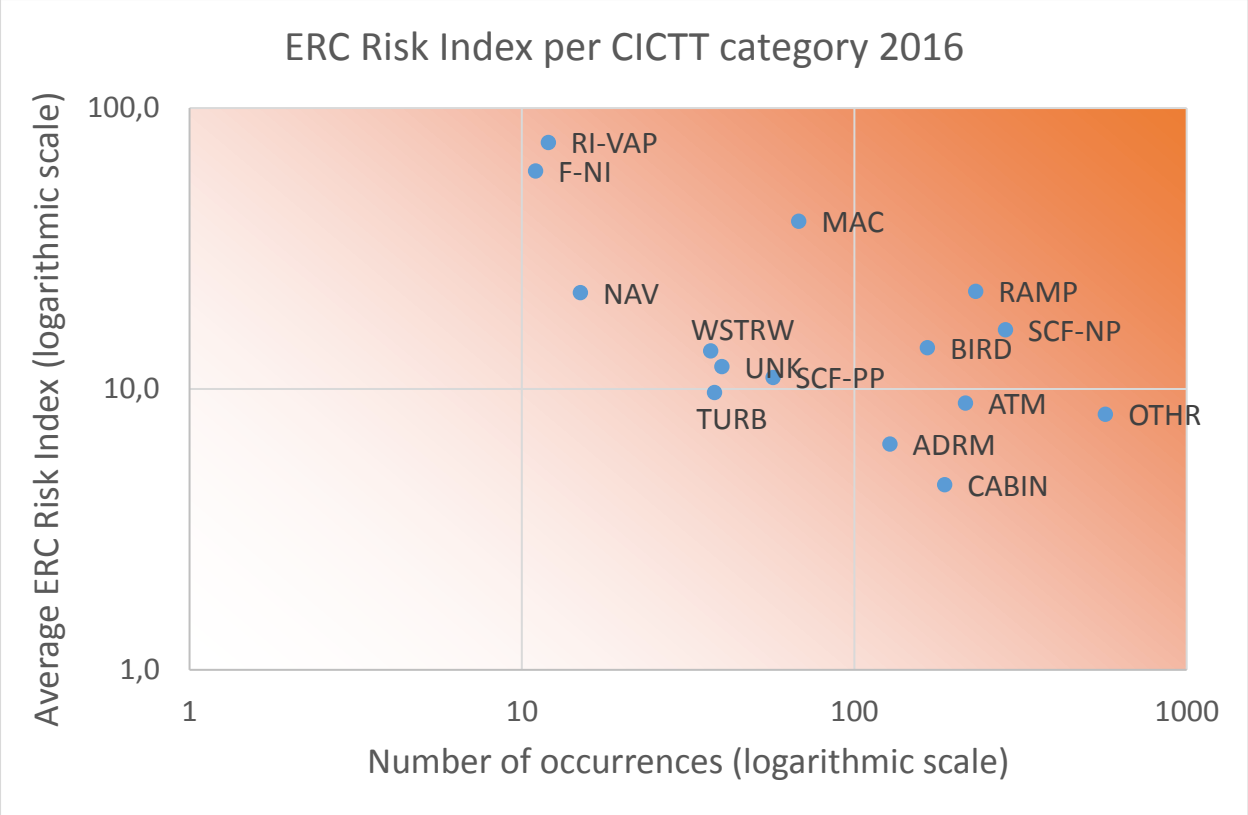


Chart No. 4: Number of occurrences and average risk index per CICTT occurrence category

Description of categories (highest 15 categories, lowest to highest):

NAV:	Navigation error
TURB:	In-flight turbulence encounter
UNK:	Unknown or undetermined
WSTRW:	Flight into windshear or thunderstorm
SCF-PP:	Failure or malfunction of an aircraft system or component - related to the powerplant
F-NI:	Fire or smoke in or on the aircraft, which is not the result of an accident impact
ADRM:	Occurrences involving aerodrome design, service, or functionality issues
CABIN:	Miscellaneous occurrences in the passenger cabin of transport category aircraft
RI-VAP:	Runway incursion by a vehicle, aircraft or person
ATM:	Occurrences involving Air traffic management (ATM) or communications, navigation, or surveillance (CNS) service issues
BIRD:	Occurrences involving collisions / near collisions with bird(s) / wildlife
MAC:	Airprox, ACAS alerts, loss of separation as well as near collisions or collisions between aircraft in flight
OTHR:	Any occurrence not covered under another category
SCF-NP:	Failure or malfunction of an aircraft system or component - other than the powerplant
RAMP:	Occurrences during (or as a result of) ground handling operations

5. “Top 10” safety issues

The CICTT categories presented in the previous paragraph are high-level categories. In order to perform a more detailed analysis of specific issues, DAC has defined and is monitoring more than 100 potential safety issues based on reported occurrences. All occurrences except some low risk occurrences are assigned to one or more of these safety issues. This also allows to distribute, and include in the analysis, the high number of occurrences that did not find their place in any meaningful CICTT category but could only be assigned to the “OTHR” basket.

It is possible to determine the most important safety issues by comparing, for each safety issue, the sum of the ERC Risk Index numbers of the associated occurrences. The ten most important safety issues are shown on the next page.

TOP 10 SAFETY ISSUES			Potential accident outcome						
	Safety issue	Accident Severity	CFIT	LOC-I	MAC	GCOL	RWY-EXC	Injury or damage in flight	Injury or damage on ground
1	Risk of MAC	Catastrophic			X				
2	Cargo moving/shifting during flight	Catastrophic		X				X	
3	W&B issues due to wrong loading	Catastrophic		X			X		
4	Runway incursion by aircraft	Catastrophic				X			X
5	Technical - pressurisation system	Catastrophic	X	X				X	
6	Technical - malfunction of automatic flight management	Catastrophic	X					X	
7	Technical - hydraulic system	Catastrophic		X			X	X	
8	Aircraft deviation from ATC instruction	Catastrophic			X	X			
9	Technical - de-icing system	Catastrophic		X					
10	Unstabilised approach	Major					X		X

X : the safety issue can lead to the potential accident outcome

Note : the following cases have been excluded:

- safety issues linked to a "minor" accident severity

- safety issues with less than 3 related occurrences

CFIT	*Controlled flight into terrain*
LOC-I	*Loss of control in flight*
MAC	*Mid-air collision*
GCOL	*Collision on ground*
RWY-EXC	*Runway excursion*

The highest risk of the tracked safety issues is the risk of mid-air collision. Whereas a decrease in number of occurrences has been observed, the average ERC Risk index of these occurrences has increased.

The former safety issue “Mismatch between calculated and actual CG (center of gravity)” has been split in two separate safety issues, according to the causes of the mismatch: “W&B (weight and balance) issues due to wrong loading” and “W&B issues due to wrong data or calculation”. The results show that wrong loading is causing a far higher risk than wrong data or wrong calculations: the first one appears in third place, while the second one is far from the “Top 10”.

Runway incursions by aircraft also appear in the “Top 10” for 2016 because of the high average Risk Index number which reflects the high risk of this type of occurrence. Even if the overall number of occurrences is small, it has increased compared to previous years. Most runway incursions in Luxembourg were caused by General Aviation, both aircraft and helicopters. Runway incursions also happened on training flights with instructors on board.

The previously mentioned increase in the number of reported system or component failures (SCF-NP) is reflected in the presence of several technical issues in the “Top 10”.

The distribution according to the potential accident outcome shows that the highest risk is associated with the LOC-I category - Loss of control in flight. The percentages shown in chart No. 5 are relative to the overall sum of the ERC risk indexes of all safety issues, not only the "Top 10". As shown in the "Top 10" table, safety issues can be associated with more than one potential accident outcome. Consequently the sum of all the percentages shown in Chart No. 5 is higher than 100%.

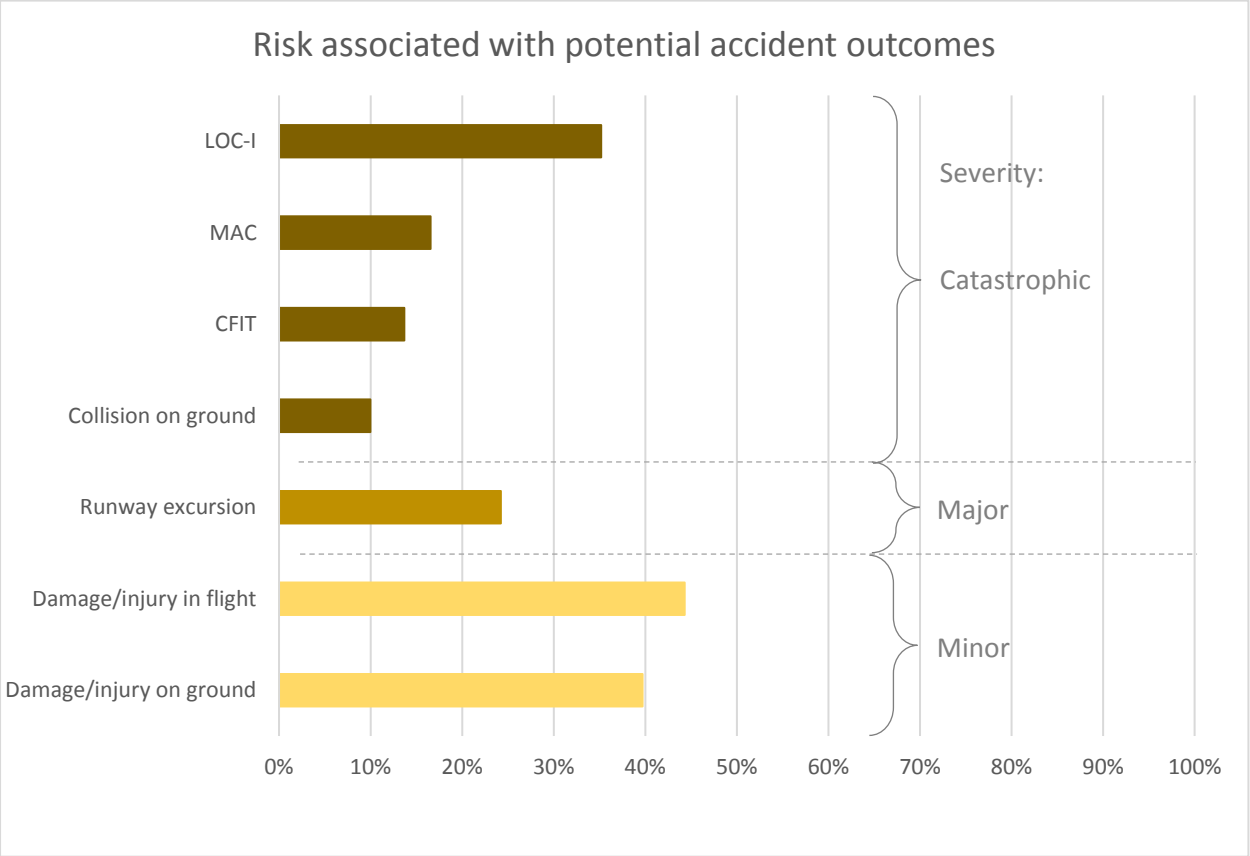


Chart No. 5: Distribution of the sum of ERC Risk indexes by potential accident outcome

LOC-I	*Loss of control in flight*
CFIT	*Controlled flight into terrain*
MAC	*Mid-air collision*

The different Safety Issues have also been categorised according to the domain of the events that can trigger them. The following table shows the domain of triggering events of the "Top 10" safety issues.

TOP 10 SAFETY ISSUES			Domain of triggering event				
	Safety issue	**Accident Severity**	**ATM**	**Aerodrome**	**Ground handling**	**Operational**	**Technical**
1	Risk of MAC	Catastrophic	X			X	
2	Cargo moving/shifting during flight	Catastrophic			X		
3	W&B issues due to wrong loading	Catastrophic			X		
4	Runway incursion by aircraft	Catastrophic	X			X	
5	Technical - pressurisation system	Catastrophic					X
6	Technical - malfunction of automatic flight management	Catastrophic					X
7	Technical - hydraulic system	Catastrophic					X
8	Aircraft deviation from ATC instruction	Catastrophic				X	
9	Technical - de-icing system	Catastrophic					X
10	Unstabilised approach	Major				X	

Chart No. 6 shows that the highest risk is associated with triggering events of the operational domain, followed by technical and ground handling issues. All safety issues, not only the "Top 10", have been considered. Again, the overall total is higher than 100% because some safety issues are assigned to more than one domain.

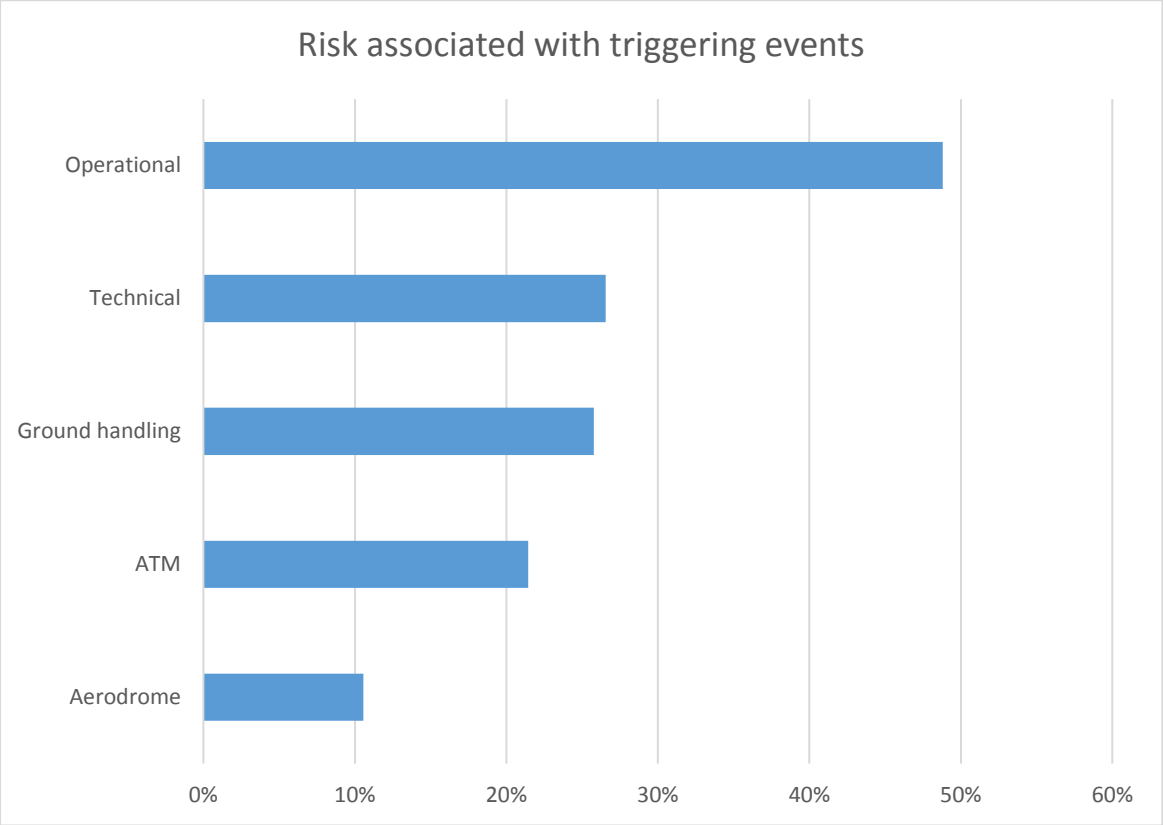


Chart No. 6: Risk associated with the different domains of triggering events

Note : This analysis is mainly based on the « ERC Risk index » values assigned by DAC to each occurrence. This allows a more detailed analysis than a simple counting of the number of occurrences, but is dependent to a large extent on the information content of the occurrence reports and a simplified evaluation of that content. As a result, an overestimation or underestimation of some safety issues cannot be excluded.

Annex I

Definitions

Source:
Regulation (EU) No.996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and repealing Directive 94/56/EC

- Accident means an occurrence associated with the operation of an aircraft which, in the case of a manned aircraft, takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, or in the case of an unmanned aircraft, takes place between the time the aircraft is ready to move with the purpose of flight until such time it comes to rest at the end of the flight and the primary propulsion system is shut down, in which:

  (a) a person is fatally or seriously injured as a result of:
  — being in the aircraft, or,
  — direct contact with any part of the aircraft, including parts which have become detached from the aircraft, or,
  — 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; or

  (b) the aircraft sustains damage or structural failure which adversely affects the structural strength, performance or flight characteristics of the aircraft, and would normally require major repair or replacement of the affected component, except for engine failure or damage, when the damage is limited to a single engine, (including its cowlings or accessories), to propellers, wing tips, antennas, probes, vanes, tires, brakes, wheels, fairings, panels, landing gear doors, windscreens, the aircraft skin (such as small dents or puncture holes) or minor damages to main rotor blades, tail rotor blades, landing gear, and those resulting from hail or bird strike, (including holes in the radome); or

  (c) the aircraft is missing or is completely inaccessible.

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

- Serious incident means an incident involving circumstances indicating that there was a high probability of an accident and is associated with the operation of an aircraft, which in the case of a manned aircraft, takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, or in the case of an unmanned aircraft, takes place between the time the aircraft is ready to move with the purpose of flight until such time it comes to rest at the end of the flight and the primary propulsion system is shut down.

ANNEX II

ARMS Methodology

DAC has adopted the ARMS – Aviation Risk Management Solutions methodology for the assessment of risks related to reported safety occurrences. The ARMS methodology was developed by a voluntary collaboration of aviation authorities, operators and air navigation service providers. It consists of two parts:

a. Risk classification of occurrences

A risk classification has been applied to each occurrence, according the ARMS methodology. The "ERC Risk index" is expressed as a number from 1 to 2500, with associated green (1-10), yellow (20-102) and red bands (≥500).

Question 2

What was the effectiveness of the remaining barriers between this event and the most credible accident scenario?			
Effective	Limited	Minimal	Not effective
50	102	502	2500
10	21	101	500
2	4	20	100
1			

Question 1

If this event had escalated into an accident outcome, what would have been the most credible outcome?		Typical accident scenarios
Catastrophic Accident	Loss of aircraft or multiple fatalities (3 or more)	Loss of control, mid air collision, uncontrollable fire on board, explosions, total structural failure of the aircraft, collision with terrain
Major Accident	1 or 2 fatalities, multiple serious injuries, major damage to the aircraft	High speed taxiway collision, major turbulence injuries
Minor Injuries or damage	Minor injuries, minor damage to aircraft	Pushback accident, minor weather damage
No accident outcome	No potential damage or injury could occur	Any event which could not escalate into an accident, even if it may have operational consequences (e.g. diversion, delay, individual sickness)

ERC – Event risk classification (ERC) according ARMS.
Source: The ARMS Methodology for Operational Risk Assessment in Aviation Organisations. Developed by the ARMS Working Group, 2007-2010

b. Safety issues

Every occurrence reported to DAC is linked to a "potential safety issue", except for the least severe (ERC Risk index 10 or less) that do not fit with any existing potential safety issue. If an occurrence with an ERC risk index higher than 10 (i.e. in the yellow or red band) does not fit with any existing "potential safety issue", a new potential safety issue is created, in order to be able to identify future recurring events.

The risk assessment (« SIRA – Safety Issue Risk Assessment ») according to the ARMS methodology, allows to identify:

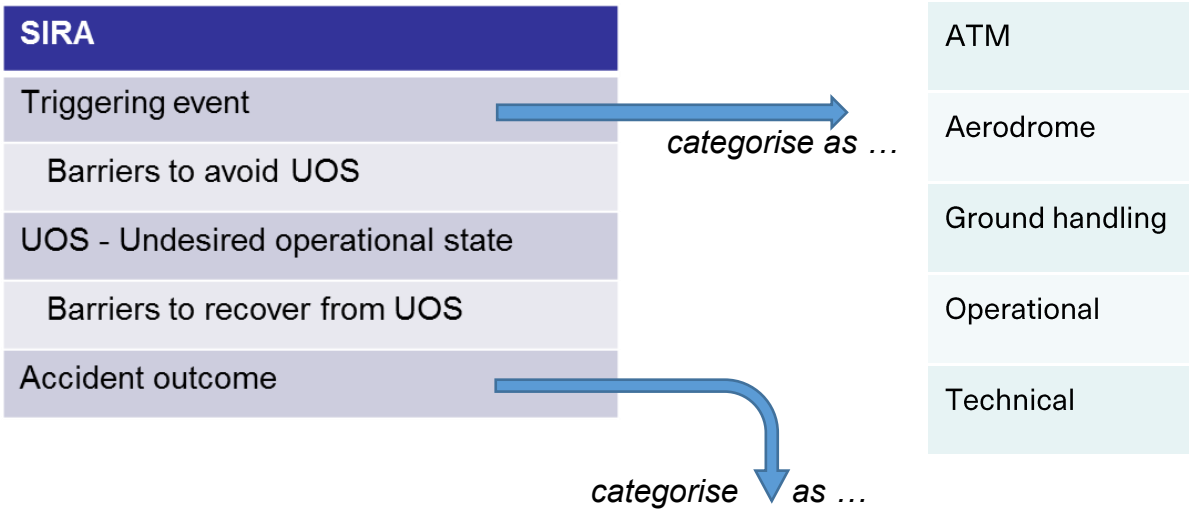
- the triggering event(s)
- the Undesired Operational state UOS

- the potential accident outcome(s)
- the safety barriers to avoid the UOS as well as the safety barriers to recover from the UOS.

In total, DAC is currently tracking more than 100 potential safety issues. To maintain an overview it is necessary to apply a classification. Two criteria have been applied by DAC:

- the domain of the triggering event:
  - ATM (Air traffic management)
  - Aerodrome
  - Ground handling
  - Operational
  - Airworthiness (technical)

- The type of potential accident outcome:
  7 types of potential accident outcome have been defined, corresponding to the "feared consequences" of the risk portfolio of DGAC France[3].



CFIT Controlled flight into terrain	LOC-I Loss of control in flight	MAC Mid-air collision	GCOL Ground collision	RE Runway ex-cursion	Damage / injury in flight	Damage / injury on ground
catastrophic	catastrophic	catastrophic	catastrophic	major	minor	minor

3 "Strategic action plan to improve aviation safety – the 2018 agenda", DGAC France