



Direction de l'Aviation civile

Annual Safety Review 2018

1. Introduction

The Annual Safety Review is compiled by the Safety Department of the Directorate of Civil Aviation Luxembourg (DAC). It examines the safety performance of civil aviation in Luxembourg during 2018 and in a 5-year timeframe between 2014 and 2018.

Luxembourg will publish its State Safety Program (SSP) soon. The State Safety Program describes the State's aviation oversight system, its legal base in the national and international context and the roles and responsibilities of the different actors.

The State Safety Program will be accompanied by a State Plan for Aviation Safety (SPAS). The SPAS will describe the actions necessary to maintain and improve aviation safety in Luxembourg. To ensure that the actions foreseen are focused on the most important areas, it is necessary to analyse the current situation concerning aviation safety. By providing this analysis, this Annual Safety Review forms a baseline for the elaboration of the SPAS.

The same process been applied at European level by the European Union Aviation Safety Agency (EASA): The European Plan for Aviation Safety (EPAS) has been elaborated on the base of EASA's Annual Safety Reviews. The national SPAS will also integrate relevant actions from the EPAS.

In addition to the annual review for 2018, this report contains an analysis for the five years 2014 to 2018. Since 2014, DAC has consistently applied the ARMS methodology (Aviation Risk Management Solutions, cf. Annex I) for the analysis of occurrence data. The reporting itself has seen significant changes during these five years, in particular due to the introduction of a new European regulation on occurrence reporting¹. Nevertheless, the bigger overall number of reports allows drawing some conclusions about Safety Issues that consistently show up over that timeframe.

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

Three accidents were reported to DAC in 2018. Two involved paragliders and one involved a parachutist. Investigations of these accidents are ongoing.

No serious incidents were reported.

Accidents						
Aircraft Type	Date	Location	Event	Outcome	Investigation	CICCTT categ.
Paraglider	15.4.	Bourscheid-moulin	Crash during landing	Serious injury	AET, ongoing	AMAN, ARC
Paraglider	2.8.	Schlinder-manderscheid	Front glider collapse, fall into trees	Minor injury	AET, ongoing	LOC-I
Parachute	19.8.	ELNT Noertrange	Manoeuvre leading to fast descent	Serious injury	AET, ongoing	ARC, OTHR

The definitions of accident, incident and serious incident are shown in Annex II.

3. Reporting of occurrences

The DAC receives, classifies and analyses occurrence reports. The reports cover:

- Events in Luxembourg's airspace, at Luxembourg's airport and other landing sites
- Events occurring outside of the national territory reported by air operators from Luxembourg.

The relevant number of flights, for which the reporting obligations apply, has increased by approximately 5% between 2017 and 2018.

The overall number of reported occurrences has increased significantly, by 34%, in 2018 over 2017. The main increase is noted in the "occurrence without safety effect" class (Events of low severity). The table on next page shows the number of occurrences: in cases where two or more persons or organisations have reported the same event, these reports have been merged and are counted as only one event.

Occurrence class	2012	2013	2014	2015	2016	2017	2018	Variation 2017-2018
Observation	332	561	454	535	470	617	704	+14%
Occurrence without safety effect	684	813	727	798	689	289	843	+192%
Incident	458	523	597	578	873	1229	1310	+7%
Serious Incident	3	1	1	3	1	2	0	
Accident	2	9	5	3	2	3	3	
Total	1479	1907	1784	1917	2035	2140	2860	+34%

The significant increase in the number of reports is due to reporting by the aerodrome operator of Luxembourg airport. In line with the entry into force of regulation (EU) No. 139/2014 on Jan. 1, 2018, the aerodrome operator was certified by DAC in December 2017. Before the certification, the aerodrome operator submitted very few reports to DAC, but as part of the certification process the reporting obligations were understood and implemented.

4. Occurrence categories

All occurrences have been attributed to one or more occurrence categories, as defined by the CICTT². The most frequent occurrence categories in 2018 are shown in Chart No.1.

As in previous years, "OTHR" (other) is the most frequent occurrence category, but with a majority of occurrences at the lowest severity level ("observation"). The categories ADRM (Aerodrome-related) and RAMP (Ground-handling) show a significant increase and have moved up to second and third place. This is due to the reporting by the aerodrome operator of Luxembourg airport: a large proportion of the additional reports received in 2018 are in one, or both, of these two categories. The majority of these occurrences are classified as "occurrence without safety effect", with relatively low severity. While the SCF-NP category (system or component failure, non-powerplant), has been relegated to fourth place overall, it remains the category with the highest number of "incidents".

2 CAST/ICAO Common Taxonomy Team

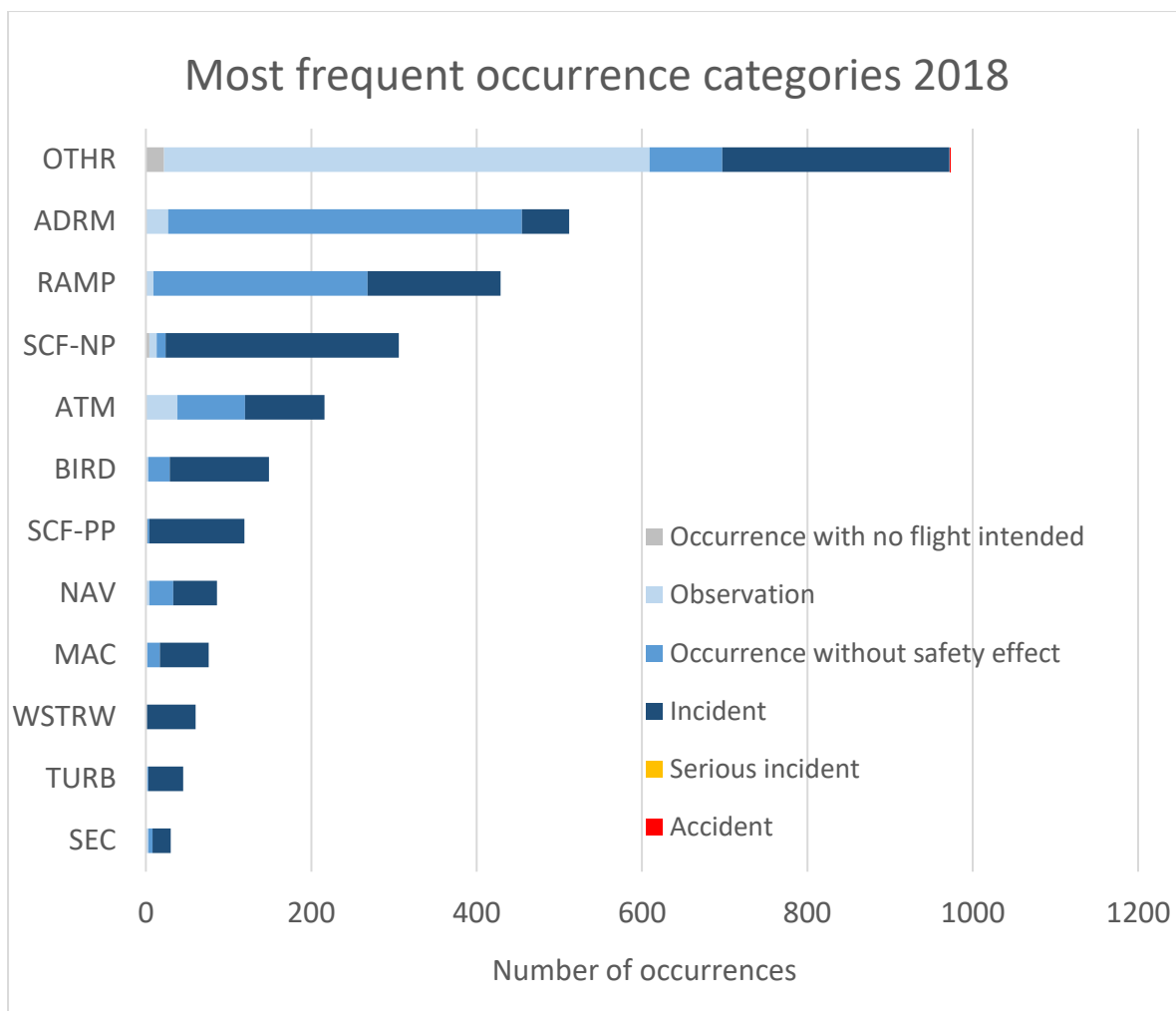


Chart No. 1: Most frequent occurrences of 2018, by CICTT category

Description of categories:

- OTHR: Any occurrence not covered under another category
- ADRM: Occurrences involving aerodrome design, service, or functionality issues
- RAMP: Occurrences during (or as a result of) ground handling operations
- SCF-NP: Failure or malfunction of an aircraft system or component - other than the powerplant
- ATM: Occurrences involving Air traffic management (ATM) or communications, navigation, or surveillance (CNS) service issues
- BIRD: Occurrences involving collisions / near collisions with bird(s)
- SCF-PP: Failure or malfunction of an aircraft system or component - related to the powerplant
- NAV: Navigation errors - Occurrences involving the incorrect navigation of aircraft on the ground or in the air
- MAC: Airprox, ACAS alerts, loss of separation as well as near collisions or collisions between aircraft in flight
- WSTRW: Flight into windshear or thunderstorm
- TURB: In-flight turbulence encounter
- SEC: Criminal/Security acts which result in accidents or incidents

5. Top Ten Safety Issues 2018

In order to perform a detailed analysis of specific issues, DAC has defined and is monitoring more than 120 potential safety issues based on reported occurrences. All occurrences are assigned to one or more of these Safety Issues. This allows a customized and more detailed overview of specific issues. Notably, the very high number of occurrences in the CICTT category “OTHR”, which does not permit any further analysis, could be distributed to meaningful Safety Issues.

It is also desirable to take into account the severity of occurrences, to assess if an occurrence had a high risk or a low risk of resulting in an accident. DAC applies the ARMS methodology where an ERC Risk Index (Event Risk Classification, cf. Annex I) is assigned to each occurrence. As the ERC Risk Index is expressed as a number, a relative comparison between the Safety Issues can be made by looking at the sum of the ERC Risk indexes of the related occurrences. This will result in a better overall risk picture than counting only the number of occurrences related to a Safety Issue. Where the risk classification methodologies are compatible, the risk classification of the reporting organisation has been considered. Where the risk classification methodologies are not directly compatible, follow-up reports from the reporting organisations are crucial to enable DAC to reproduce the operator’s own evaluation.

The ten most important Safety Issues for 2018 have been identified by the highest sum of ERC Risk Index of the related occurrences. They are shown in the table on next page.

TOP 10 SAFETY ISSUES 2018			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 Mid-Air Collision*	Catastrophic			X				
2	Fatigue	Catastrophic	X	X		X	X	X	X
3	Dangerous Goods handling*	Catastrophic		X				X	
4	Windshear	Catastrophic		X			X	X	X
5	FOD (Foreign object damage)	Major							X
6	Technical - flight controls	Catastrophic		X			X	X	X
7	Jet blast / Prop hazard*	Major							X
8	Engine failure or problems - multi-engine aircraft	Catastrophic	X	X			X	X	
9	Unstabilized approach	Major					X		X
10	Cargo moving/shifting during flight	Catastrophic		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 during the year

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

The position of a Safety Issue in the Top Ten can be the result of a limited number of occurrences with relatively high ERC Risk indexes, or of a high number of occurrences with low ERC Risk indexes. In a few cases, one single high-risk event can have a significant impact on the ranking of the associated Safety Issue, even up to pushing it into the Top Ten for the year. This is the case for the Safety Issues marked with an asterisk* in the Top Ten table on the previous page. The high-risk events of 2018, in addition to the three reported accidents, are:

- Operational: one encounter between a commercial aircraft and a paraglider (USA)
- Technical: a part of the flaps lost in flight (China)
- Ground handling: three events at Luxembourg airport, one each involving:
 - o aircraft towing
 - o damaged dangerous goods
 - o jet blast hazard on the cargo apron P7

As explained in Annex I and shown in the Top Ten table for 2018, all Safety Issues have been associated with one or more potential accident outcome. The overall risk associated to each potential accident outcome can then be evaluated by adding the ERC Risk indexes of all related Safety Issues. This is shown in Chart No. 2, as percentage of the overall sum of the ERC Risk indexes of all Safety Issues. Chart No. 2 shows that there is no significant evolution in 2018 compared to the years 2014-2017. The highest risk, for a potential “catastrophic” accident outcome, is still associated with the LOC-I category - Loss of control in flight. There is a diminution of about 5% for the Safety Issues potentially leading to CFIT (Controlled flight into terrain) and GCOL (Collision on the ground).

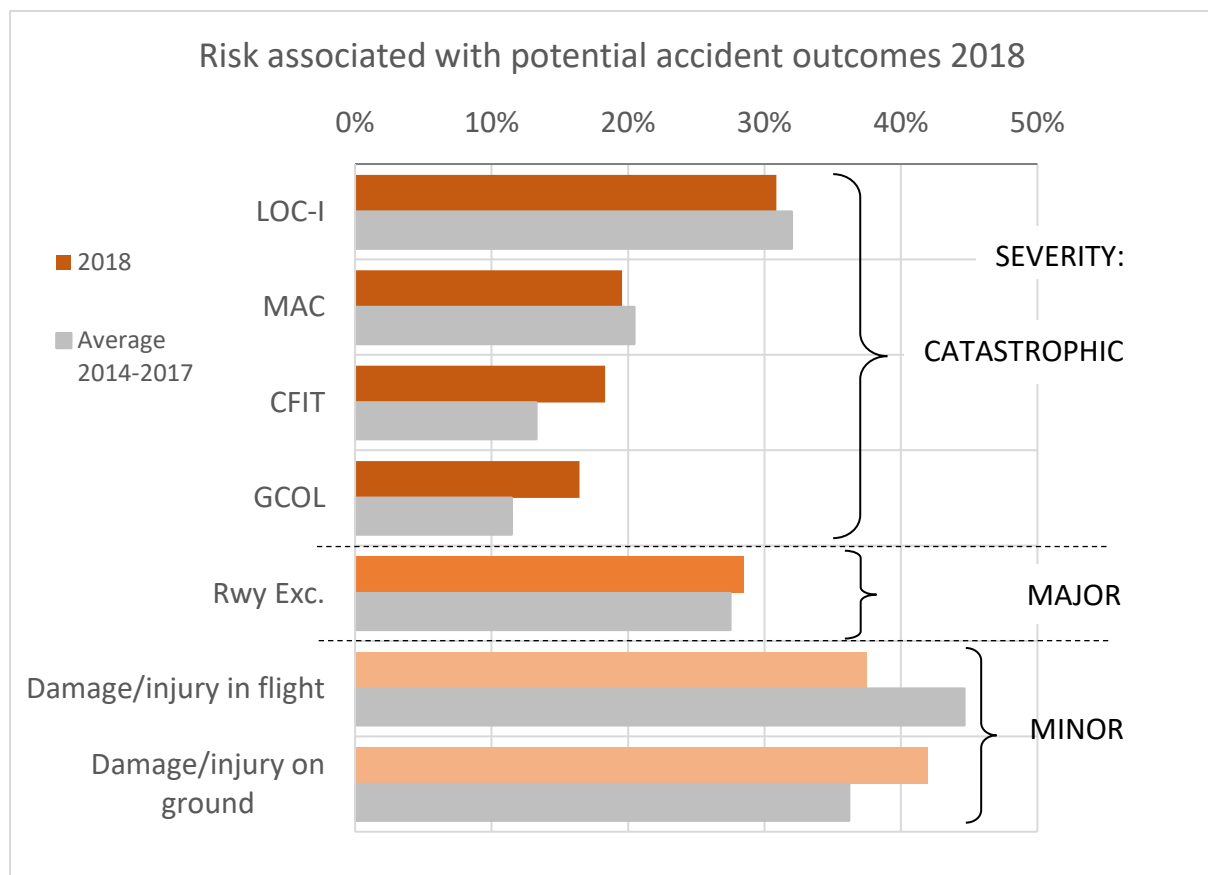


Chart No. 2: Risk associated with potential accident outcomes

6. Top Ten Safety Issues 2014-2018

As explained before, the annual Top Ten can be impacted by a small number of accidents, serious incidents or other high-risk events. Therefore, it makes sense to study a bigger number of occurrences, by choosing a longer timeframe. DAC has consistently applied the ARMS methodology since 2014, so an analysis covering five years 2014-2018 is possible.

The ten most important Safety Issues over the five years have been identified by the highest sum of ERC Risk Index of the related occurrences over this timeframe. They are shown in the table below, followed by a brief analysis of the most significant ones.

Safety Issue	Trend 2018 compared to average 2014-2017	Trend 2018 compared to 2017
1 Risk of Mid-Air Collision		
2 Cargo moving/shifting during flight		
3 Fatigue		
4 Dangerous Goods handling		
5 Weight & Balance issues due to wrong loading		
6 Airspace infringement		
7 Technical - flight controls		
8 Loss of control during landing		
9 Runway incursion by aircraft		
10 Engine failure or problems - single engine aircraft		

increasing trend

decreasing trend

approximately stable

Note : the following cases have been excluded:

- Safety Issues linked to a "minor" accident severity
- Safety Issues with less than 10 related occurrences during 5 years

- Risk of Mid-Air collision

Over 5 years, this Safety Issue is consistently at the very top of the list or in second position. Compared to 2017, both the number and the average ERC Risk Index are similar.

- Cargo moving/shifting during flight

This Safety Issue shows a significant decrease from 2014 up to 2017, followed by a small increase for 2018. The small increase is due to an increase in the number of events.

- Fatigue

Since 2017, DAC has specifically requested all fatigue reports from one operator (which would typically not fall under the mandatory reporting obligation). As a result, a very high number of reports with usually a very low ERC Risk index has been received since the second quarter of 2017. Although reporting was available for the full year 2018 but only for part of the year 2017, the increase of 2018 vs. 2017 is not due to a higher number, but to the average Risk Index of these occurrences being a little higher.

- Dangerous Goods handling

Some high-risk occurrences in 2017 and 2018 led to an increase for those 2 years. For 2018, the number of occurrences has increased as well.

- Weight and balance issues due to wrong loading

There is a significant decrease. The number of events has decreased but especially their average ERC Risk Index. This Safety Issue does not include weight and balance issues due to wrong calculations or wrong data, which are tracked as a separate Safety Issue that does not appear in the Top Ten.

Other Safety Issues with significant negative trends

- Jet blast/prop hazard

2018 saw some occurrences related to jet blast hazard on the cargo apron (P7) at Luxembourg airport. The jet blast of incoming aircraft, turning from the apron centerline to its parking spot, can affect personnel working on an opposite parking spot.

- Windshear

While being relatively stable from 2014 to 2017, 2018 saw an increase in both the number and the severity of reported windshear encounters. Only a minority of the occurrences happened in Luxembourg.

- FOD – Foreign object damage

While an increase in the severity of reported events was noted in 2017, 2018 saw a decrease in severity. However, this was more than compensated by a significant increase in the number of reported foreign object found. The improved reporting by the airport operator in 2018 enables a better assessment of this risk.

- Unstabilised approach

The negative trend in 2018 does not result from an increase in the number of occurrences but from an increase in the average ERC Risk Index.

Other Safety Issues with significant positive trends

While the main object of this report is to point out the main issues, it is also worth looking at the most significant improvements:

- Icing

Occurrences related to icing show a significant improvement, with very low numbers and very low severity in both 2017 and 2018.

- Hard landing

A few hard landings are reported every year. For 2017 and 2018, there were none of significant severity.

- Laser interference

The number of reports about interference by laser pointers has decreased since 2015.

- Technical - pressurization system
- ATC coordination issue (between 2 different ATC units)

7. Top five Safety Issues per domain

Each Safety Issue is also associated with one or more aviation domains, depending on the type of events that can cause the Safety Issue. For example, the risk of mid-air collision can have as triggering event either an issue in Air Traffic Management (ATM) or a flight operations issue, related to the conduct of the flight.

Each Safety Issue has been associated in this way to one, or more, of the five domains: ATM (Air Traffic management), Air Operations, Ground handling, Aerodrome, Technical. The five most important Safety Issue per domain have been determined over the same period of five years. They are shown in the tables on next page.

Air Traffic Management

Risk of Mid-Air Collision

Runway incursion by aircraft

Level bust / Altitude bust

ATC coordination issue (between 2 different ATC units)

Runway occupied

Air Operations

Risk of Mid-Air Collision

Fatigue

Airspace infringement

Loss of control during landing

Runway incursion by aircraft

Ground handling

Cargo moving/shifting during flight

Dangerous Goods handling

Weight & Balance issues due to wrong loading

FOD (Foreign object damage)

Jet blast / Prop hazard

Aerodrome

FOD (Foreign object damage)

Vehicles cutting off aircraft entering/exiting apron at Luxembourg

Runway excursion

Runway incursion by a vehicle

Taxiway incursion by vehicle at Luxembourg airport

Technical

Technical - flight controls

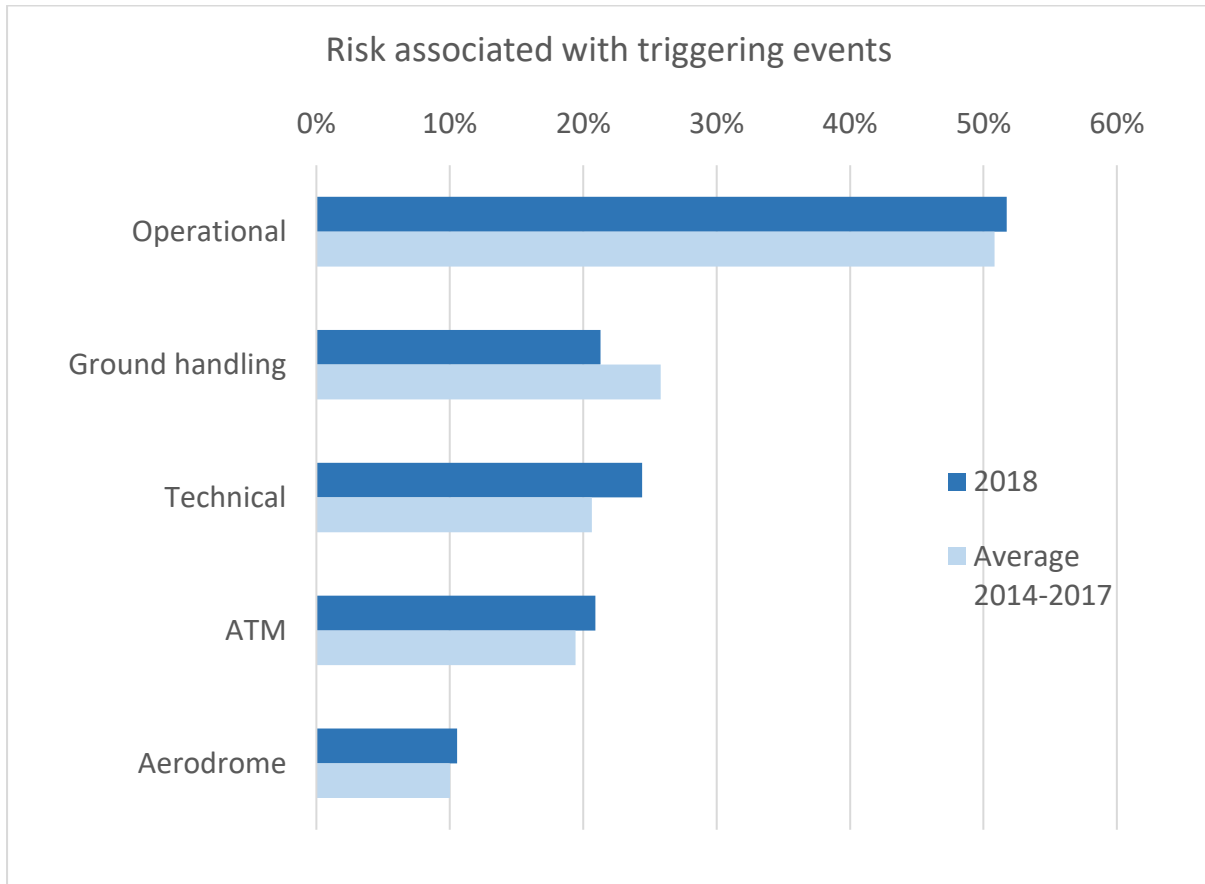
Engine failure or problems - single engine aircraft

Engine failure or problems - multi-engine aircraft

Aircraft released with incomplete maintenance tasks

Technical - pressurisation system

As for the potential accident outcomes, the relative risk related to the 5 domains can be evaluated by the sum of the related Safety Issues. Chart No. 3 shows that Safety Issues with triggering events the “operational” domain carry the highest risk. A decrease can be detected for the risk related to the “Ground handling” domain, even though the number of reported events has increased.



*Chart No. 3:
Risk associated with domains of triggering events, 2018 vs. average of 2014-2017*

Highest risks for General aviation

The overall number of occurrence reports from General aviation remains very low. The two main Safety Issues for General aviation, from the reports received between 2014 and 2018 are:

- Loss of control during landing
- Engine failure or problems - single engine aircraft

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

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 (“ERC- Event Risk classification”) has been applied to each occurrence, according to 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?	
Catastrophic Accident	Loss of aircraft or multiple fatalities (3 or more)
Major Accident	1 or 2 fatalities, multiple serious injuries, major damage to the aircraft
Minor Injuries or damage	Minor injuries, minor damage to aircraft
No accident outcome	No potential damage or injury could occur

Typical accident scenarios
Loss of control, mid air collision, uncontrollable fire on board, explosions, total structural failure of the aircraft, collision with terrain
High speed taxiway collision, major turbulence injuries
Pushback accident, minor weather damage
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”. 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:

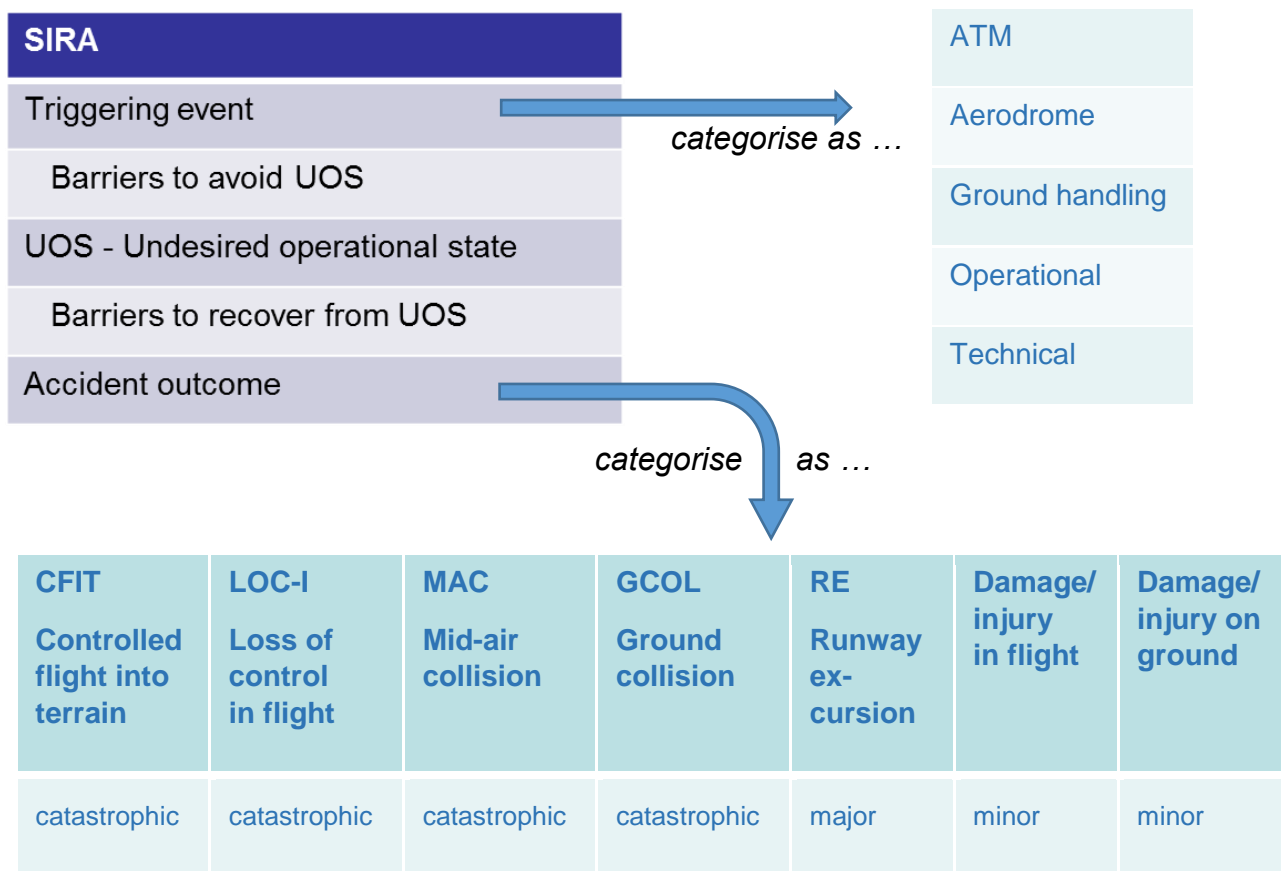
- the triggering event(s)
- the Undesired Operational state UOS
- the potential accident outcome(s)
- the safety barriers to avoid the UOS as well as the safety barriers to recover from the UOS.

In total, DAC is currently tracking more than 120 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:
 - o ATM (Air traffic management)
 - o Aerodrome
 - o Ground handling
 - o Operational
 - o 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 France³.



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

ANNEX II

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.