



LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG
Ministère de la Mobilité
et des Travaux publics

Direction de l'aviation civile

Direction de l'Aviation civile

Annual Safety Review 2022

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Accidents and serious incidents

In 2022, no accident and no serious incidents were recorded in Luxembourg airspace or on airfields in Luxembourg. Aircraft registered in Luxembourg were involved in only one serious incident, resulting in no injury and only minor damage.

	Aircraft type	Date	Location	Event	Investigation
Serious incident	Bombardier Global 6000	7.4. 2022	London-Luton (UK)	Wingtip strike during go-around	AAIB-UK closed

An investigation into this serious incident has been conducted by the AAIB-UK and a final report has been published. The serious incident presents many similarities to another serious incident involving an aircraft registered in Luxembourg: On 30.8.2020, a Bombardier Global 5000 of another operator suffered a wingtip strike with minor damage on landing in Montichiari (IT). Common factors are:

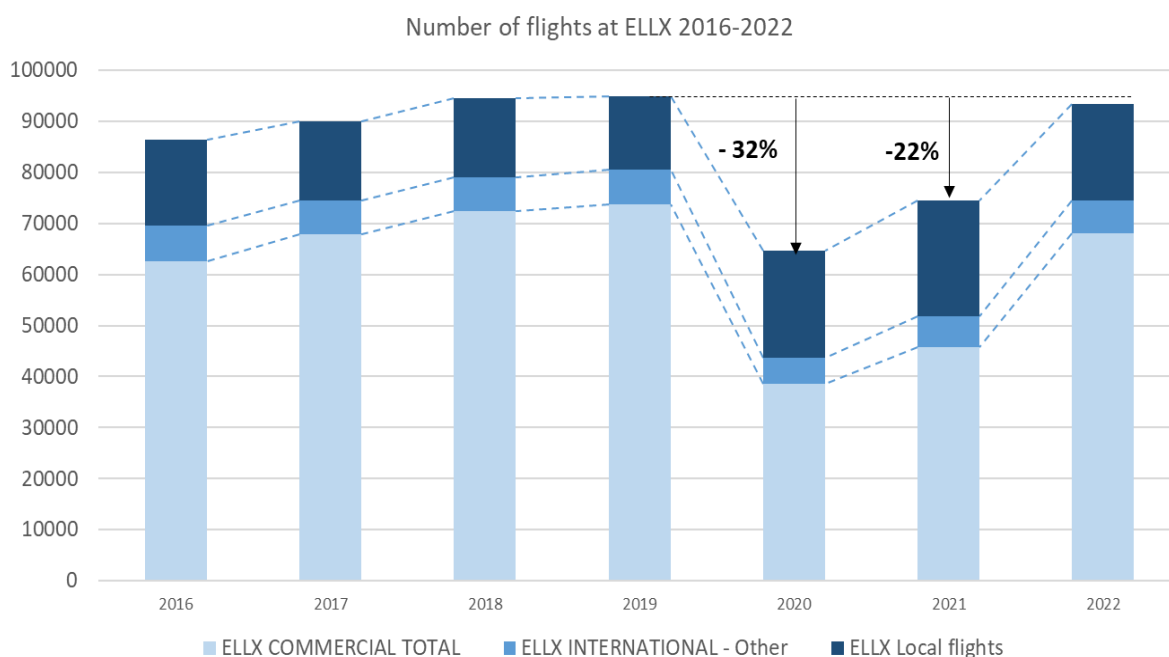
- Crosswind during landing
- Low crew experience (also affected by the pandemic in the 2020 occurrence)
- Due to the high wing sweep angle of these aircraft, the wingtips are relatively far aft. Consequently, at high pitch angle, the wingtip clearance and roll tolerance are reduced.

The longer-term evolution of the yearly number of accidents and serious incidents should be analysed with caution due to the very low numbers, which can rapidly change year over year. There is a clear decrease in the average number of accidents, however the average number of serious incidents does not follow the same trend. Moreover, it is noticeable that for almost every year up to 2020, there are less serious incidents than accidents. This is contrary to the usual distribution: serious incidents are typically more frequent than accidents.

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Accidents	2	9	5	3	2	3	3	0	1	1	0
Serious Incidents	3	1	1	3	0	2	0	0	2	3	1

Evolution of traffic

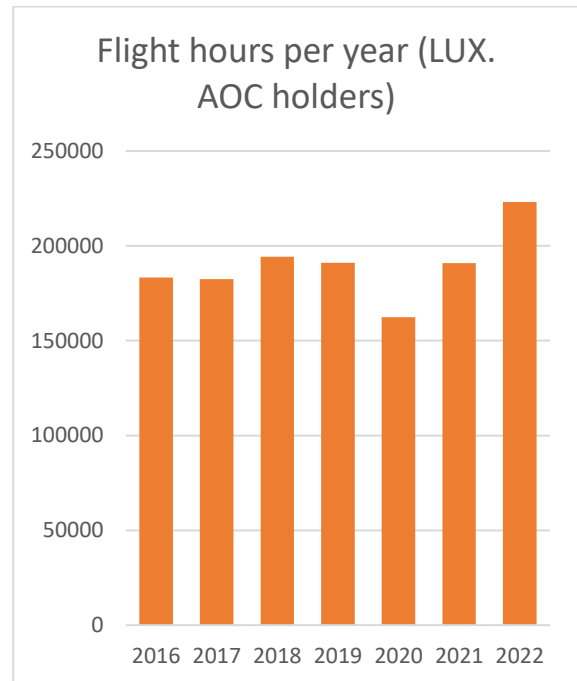
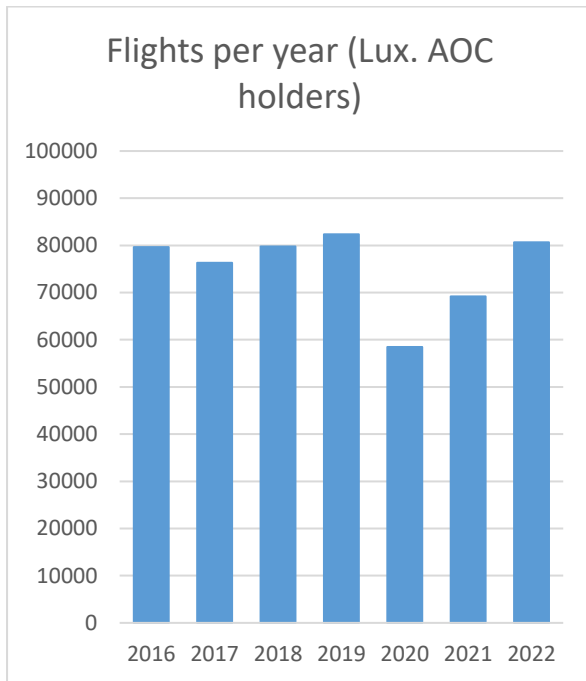
Following the reduction in traffic due to the pandemic of 2020 and 2021, the overall traffic at Luxembourg airport recovered to almost the same level as in 2018 and 2019. However, the distribution of traffic components is different: the commercial traffic has not fully recovered, while the local traffic remains higher than before the pandemic. In combination, these two factors lead to a 25% increase in overall traffic in 2022 compared to 2021.



Source data: Administration de la Navigation aérienne

Regarding air operators certified in Luxembourg, their total number of flights has almost fully recovered to the same level as in 2019, before the pandemic. In 2021, the total number of hours flown was already about equal to the hours flown in 2019, due to the higher proportion of cargo flights, which have a longer duration. The trend to more flights of longer duration is confirmed for 2022: the total flight hours of air operators certified in Luxembourg is the highest so far, being 17% higher than in 2019. The continued increase is partially due to detours necessary due to the closure of Ukrainian and Russian airspace.

Regarding air operators certified in Luxembourg, their total number of flights has almost fully recovered to the same level as in 2019, before the pandemic. Regarding flight hours, the total is the highest so far, being 17% higher than in 2019. A trend to longer flights on average was noted last year due to the higher proportion of cargo flights, which have a longer duration. For 2022, this trend was stopped because two opposite trends cancelled each other out: The recovery of shorter passenger flights was counteracted by even longer cargo flights, partially due to detours necessary due to the closure of Ukrainian and Russian airspace.





Reporting of occurrences

The Direction de l'Aviation civile (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 certified in Luxembourg and private pilots licensed in Luxembourg.

Both mandatory and voluntary reports (according Regulation (EU) 376/2014) are included in this analysis.

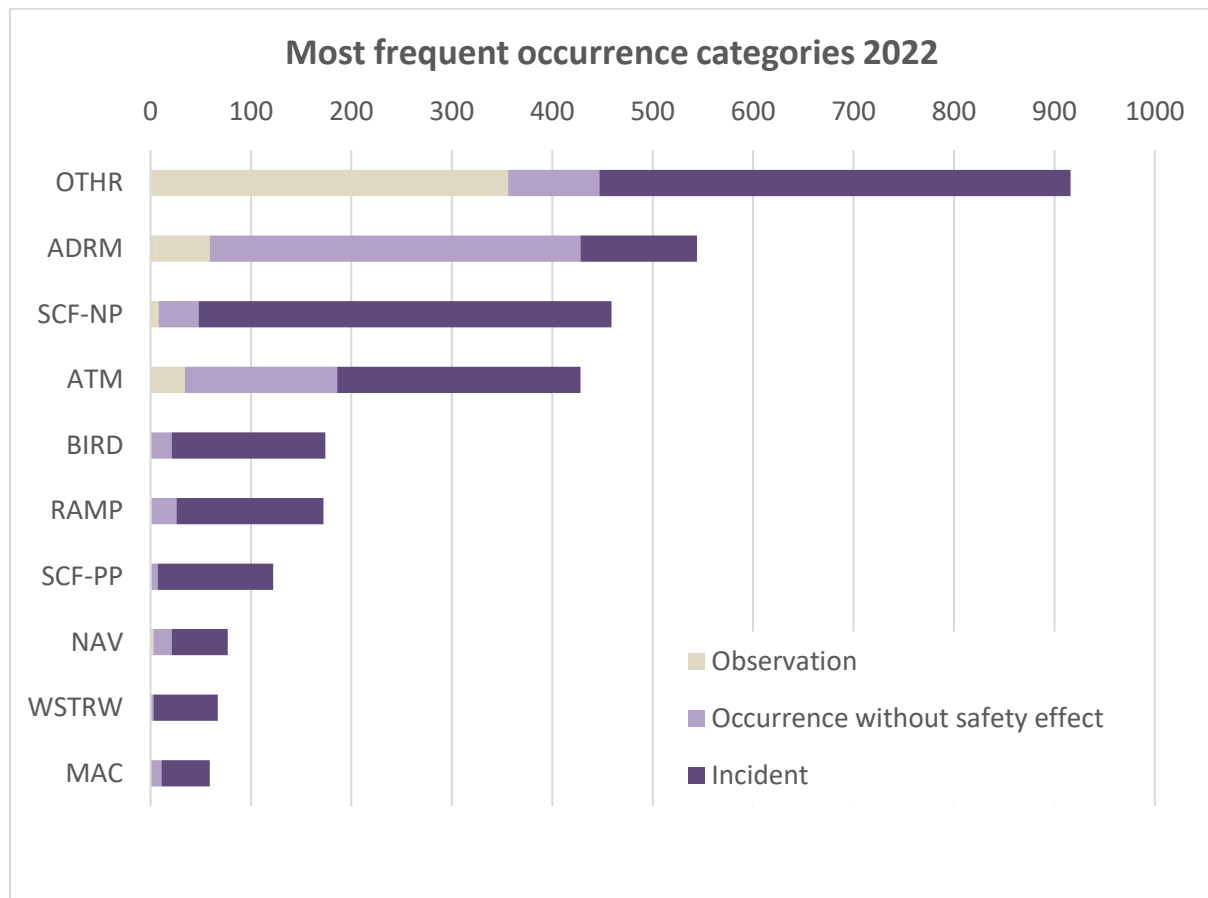
The number of reports per occurrence class is shown in the table below. In this table, two or more reports concerning the same event have been merged.

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Variation 2021- 2022
Proactive report / Observation / Occurrence with no flight intended	332	561	454	535	470	617	704	488	232	288	465	+61%
Occurrence Without Safety Effect	684	813	727	798	689	289	843	883	563	873	750	-14%
Incident	458	523	597	578	873	1229	1310	1473	1256	1699	1887	+11%
Serious Incident	3	1	1	3	0	2	0	0	2	3	1	
Accident	2	9	5	3	2	3	3	0	1	1	0	
Total	1479	1907	1784	1917	2034	2140	2860	2844	2054	2864	3103	+8%

For the first time, the overall number of reported safety occurrences exceeds 3000. The increase is in line with expectations, due to the increase in traffic.

Occurrence categories

All occurrences have been attributed to one or more occurrence categories, as defined by the CICTT¹. The most frequent occurrence categories in 2022 are shown in the chart below.



Definition of categories:

- OTHR:** Any occurrence not covered under another category
- ADRM:** Occurrences involving aerodrome design, service, or functionality issues
- 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)
- RAMP:** Occurrences during (or as a result of) ground handling operations
- 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
- WSTRW:** Flight into windshear or thunderstorm
- MAC:** Airprox, ACAS alerts, loss of separation as well as near collisions or collisions between aircraft in flight

¹ CAST/ICAO Common Taxonomy Team

The most frequent Category, “OTHR”, does not provide an appropriate basis for further analysis. For the following categories, the comparison to 2021 can reveal some interesting trends. The “ATM” category dropped from second most frequent category in 2021 to the fourth position. This is due to specific reasons which will be analysed in the “Main Safety Issues – Luxembourg” section of this report. The categories RAMP and BIRD show a small decrease, while SCF-PP remains stable. The other categories all show increasing numbers, reflecting the overall increase.

Main Safety Issues

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” can 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. Up to the year 2022 included, DAC applied the ARMS methodology where an ERC Risk Index (Event Risk Classification, cf. Annex II) 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 organisation are crucial to enable DAC to understand the risks and to reproduce the operator’s own evaluation.

The ten most important Safety Issues for 2022 have been identified by the highest sum of ERC Risk Index of the related occurrences. They are shown in the table below.

Safety Issue	
1	Fatigue
2	Risk of Mid-Air Collision
3	FOD
4	Windshear
5	Engine failure or problems - multi-engine aircraft
6	Technical - Landing gear
7	Incorrect aircraft setup by crew
8	Unstabilized approach
9	Aircraft deviation from ATC instruction
10	Technical - flight controls

Evolution of the main Safety issues

Fatigue

Although occurrences of crew fatigue are on average of low risk, the high number of related reports puts this safety issue in the highest position by a significant margin. Compared to 2021, the number of reports has increased by 50% and the average Risk index has also slightly increased. Longer flight times may have contributed to the related increase. A small percentage of the fatigue reports is also filed by crews of operators that were not affected by this issue before.

Risk of Mid-air collision

The number of occurrences involving a risk of mid-air collision is higher than in 2021 but lower than in the years before the COVID-19 pandemic (2017-2019). However, the average risk index is lower than in previous years: although the severity of the potential outcome is always assessed as “catastrophic”, the remaining safety barriers were in general assessed as sufficiently effective to prevent a mid-air collision.

Incorrect aircraft setup by crew / Unstabilized approach

These two operational Safety issues are in the Top Ten for the third year in a row, starting in 2020. An impact of the COVID-19 pandemic, leading to a deterioration of crew skill, experience and knowledge, was therefore assumed. However the number of related occurrences did not decrease when compared to 2020 and 2021. It also remains significantly higher than before the pandemic.

Aircraft deviation from ATC instruction

This safety issue appears in the Top Ten for the first time. The past evolution shows a steady increase in the number of related occurrences that was only interrupted in 2020 and 2021 by the pandemic. It should be noted that reporting obligations to DAC for this issue lie with flight crew from Luxembourg operators, independently of the location of the occurrence, and with Air traffic controllers acting only in Luxembourg and nearby delegated airspace. About 2/3 of these occurrences are located outside Luxembourg, which shows that the reporters are flight crew who report, in many cases, their own errors or deviations.

Other notable trends

For some Safety issues that are currently not among the Top Ten, significant trends were detected. Two Safety issues are represented in low overall numbers, but with a notable increase:

- Hard landing
- Risk of Controlled Flight into Terrain (CFIT)

In addition, the number of cases of medical issues affecting passengers during flight almost doubled when compared to 2019.

On the other hand, some Safety issues present positive trends. This is the case for a number of Safety issues related to cargo handling: 4 significant Safety issues present a long-term decreasing trend since 2014. These are:

- Handling of Dangerous goods (DGR)
- Weight and balance issues due to wrong data or wrong calculation
- Weight and balance issues due to wrong loading
- Cargo moving/shifting during flight

Although all 4 Safety issues present the same significant improvement, in relative comparison the number of occurrences related to handling of Dangerous goods remains by far the highest among these Safety issues.

Main Safety Issues - Luxembourg

The occurrences reported to DAC Luxembourg can be split in 2 groups: those that happen worldwide to operators certified in Luxembourg or to pilots licenced in Luxembourg, and those that happen in Luxembourg airspace or at Luxembourg airport. This means that a specific ranking of the Safety Issues for the airspace and airport of Luxembourg is possible. It includes some Safety issues that are also found in the overall Top Ten, but also some more specific items. The table below presents the Top Ten Safety Issues related to occurrences that happened in Luxembourg, with the Safety issues that are common with the overall Top Ten highlighted in green.

Safety Issue	
1	FOD
2	Fatigue
3	Risk of MAC
4	Engine failure or problems - multi-engine aircraft
5	FDP Issues at ELLX
6	Vehicles cutting off aircraft at ELLX entering/exiting apron
7	Improper installation of parts
8	Windshear
9	Airspace infringement
10	Fuel leak on ground - technical issues (risk of fire)

Compared to 2021, the rate of occurrences per 1000 flights at Luxembourg airport decreased by 9%. However, the number of reports in 2021 was inflated by two specific factors: the refurbishment of the runway, and issues with the ATM Surveillance chain at Luxembourg airport. The runway refurbishment works continued in 2022 and related Safety issues were present accordingly, notably, FOD (Foreign objects/debris). However, the number of occurrences related to the Surveillance chain issues decreased by 50%. This factor explains the 9% overall decrease in occurrences: In fact, the rate per 1000 flights of occurrences other than those related to Surveillance chain issues increased by 10%.

FOD Foreign object/ debris

The very high number of FOD reports is the consequence of the second phase of Runway refurbishment works. As during the first phase in 2021, almost all FOD reports originated from patrols and inspections on the lookout for FOD. The inspections acted as an effective safety barrier, so that a very low Risk index could be assigned to almost all FOD reports. Nevertheless, due to their high number this Safety issue remains in first place in the specific Top Ten for Luxembourg.

As in 2021, the safety measures put in place to prevent runway incursions by work vehicles were effective: only one directly related runway incursion was recorded.

Surveillance Chain issues

The drop of 50% in the number of related occurrences constitutes a significant improvement. However, the number recorded in 2022 remains far higher than before the Surveillance chain upgrade of June 2019. Whereas two related Safety Issues, concerning FDP (Flight Data Processing) and the ATM radar, were present in the Top Ten in 2021, only one - FDP issues - remains in the Top Ten in 2022. The Safety issue related to Radar dropped out of the Top Ten, but only just: is now occupies the 11th place.

Vehicles cutting off aircraft at ELLX entering/exiting apron

This Safety issue related to driving at Luxembourg airport was of concern years ago, before undergoing a significant improvement. However, both the number and the average severity of such occurrences increased already in 2021. In 2022, especially the average severity increased again.

Conclusion

Aviation in Luxembourg has recovered to a similar level as before the pandemic of 2020. A high safety level was maintained throughout, with only one serious incident in 2022 and a long-term decrease in the number of accidents.

In the analysis based on the ERC Risk Index of occurrences, crew fatigue is identified as the highest risk in 2022, surpassing the risk of mid-air collision. This report also identifies several other safety issues that are of concern or present a negative trend. They will be considered for the upcoming update of the National Plan for Aviation Safety¹.

1 [Programme-national-de-securite-aerienne-002-.pdf \(gouvernement.lu\)](#)

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 (“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:

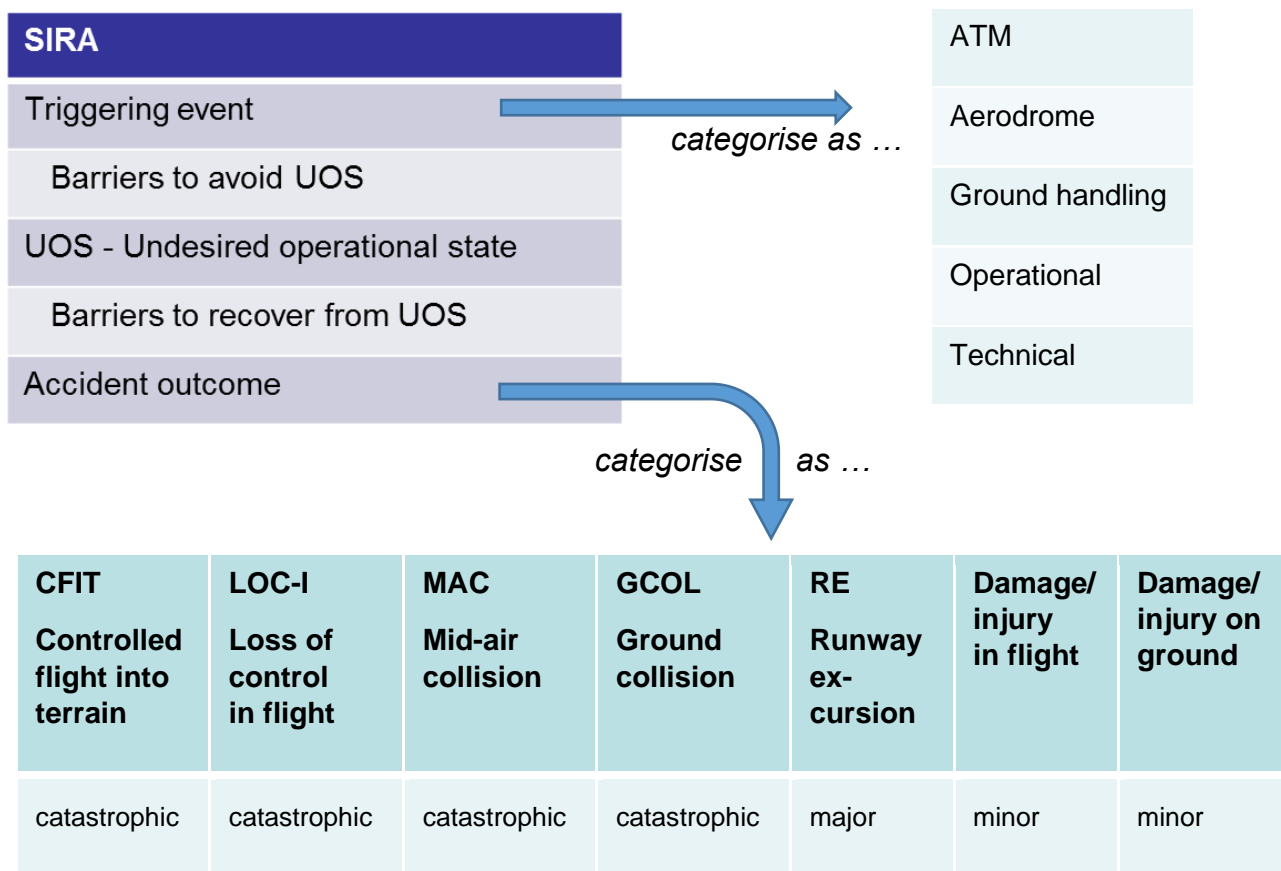
- the triggering event(s)
- the Undesired Operational State UOS
- the potential accident outcome(s)
- the safety barriers to avoid the UOS as well as the safety barriers to recover from the UOS.

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 France¹.



¹ “Strategic action plan to improve aviation safety – the 2018 agenda”, DGAC France