THE GOVERNMENT
OF THE GRAND DUCHY OF LUXEMBOURG
Ministry of Mobility and Public Works

Directorate of Civil Aviation

Direction de l'Aviation civile

Annual Safety Review 2024

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Accidents and serious incidents

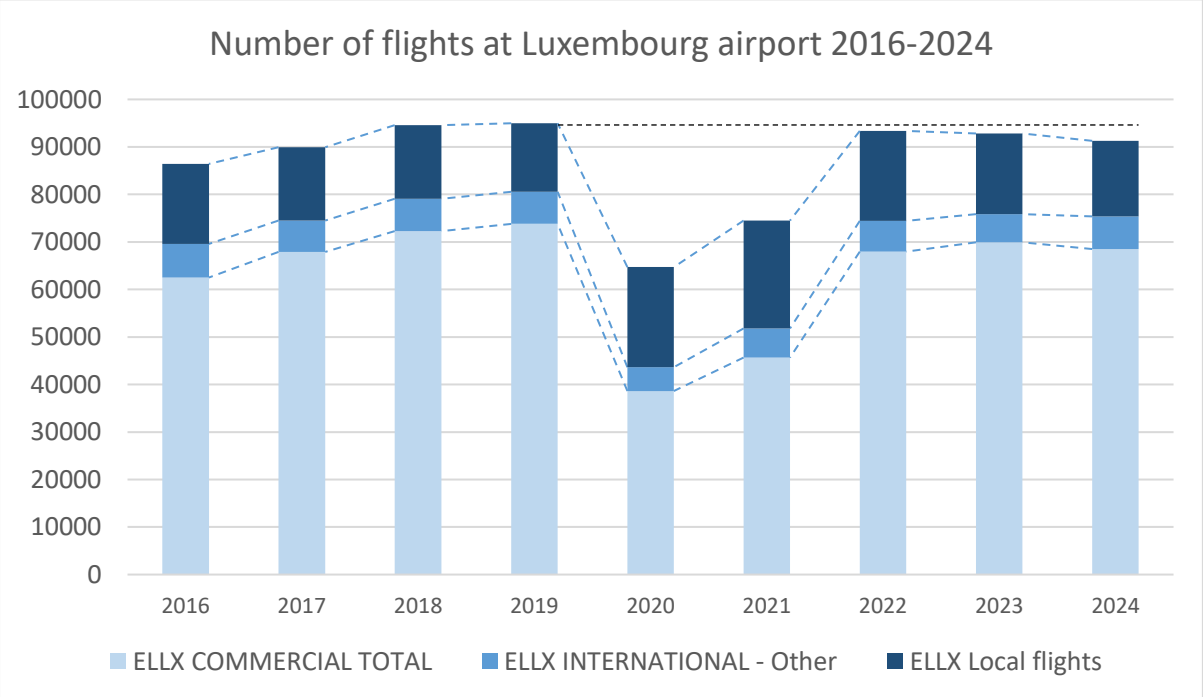
No accidents nor serious incidents were recorded in 2024.

This continues the long-term decreasing trend. In total over the years, there are more accidents than serious incidents, which is contrary to the expected distribution.

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Accidents	2	9	5	3	2	3	3	0	1	1	0	2	**0**
Serious Incidents	3	1	1	3	0	2	0	0	2	3	1	0	**0**

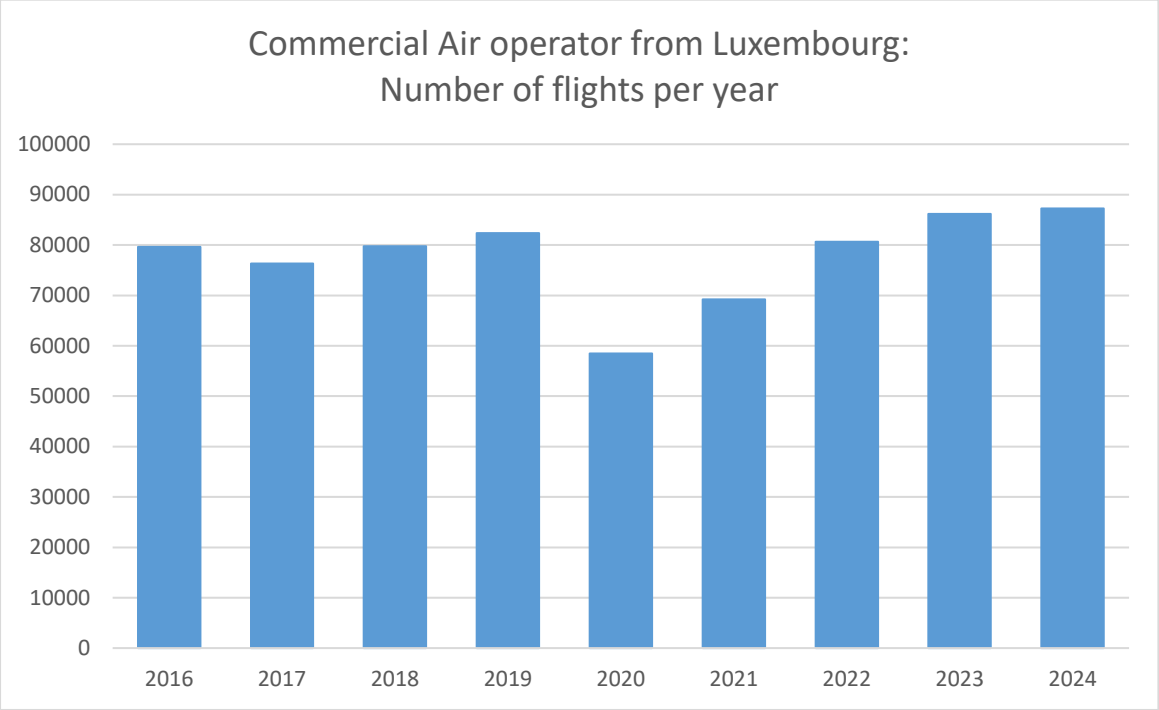
Evolution of traffic

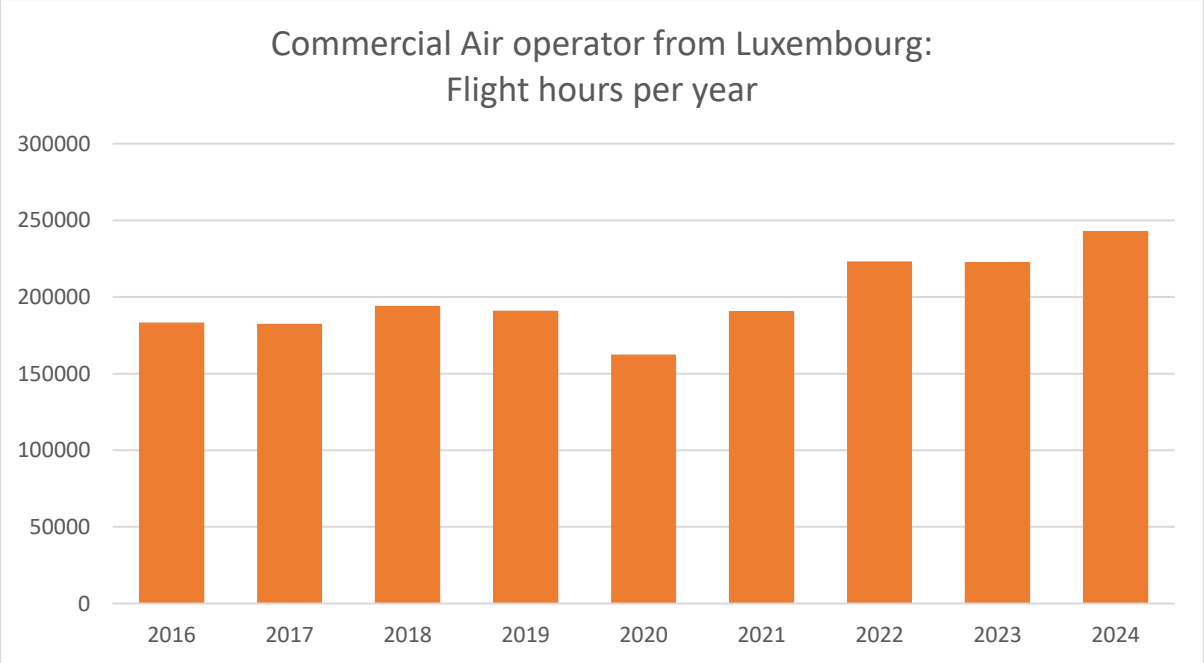
The overall traffic at Luxembourg airport shows a small decrease in the number of flights when compared to previous years. The number of commercial flights and the number of local flights has decreased slightly, only the number of non-commercial international flights has increased.



Source data: Administration de la Navigation aérienne

Regarding air operators certified in Luxembourg, their total number of flights (worldwide) is relatively stable around 87 000 flights. However, the total of flights hours has increased by 9% over 2023 and now reaches almost 243 000 flight hours. While in 2023 a trend to shorter flights on average was observed, this has been reversed in 2024. All air operators have seen an increase in flight hours in 2024.





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	2023	2024
Proactive report / Observation / Occurrence with no flight intended	332	561	454	535	470	617	704	488	232	288	465	620	**1071**
Occurrence Without Safety Effect	684	813	727	798	689	289	843	883	563	873	750	595	**505**
Incident	458	523	597	578	873	1229	1310	1473	1256	1699	1887	2074	**2337**
Serious Incident	3	1	1	3	0	2	0	0	2	3	1	0	**0**
Accident	2	9	5	3	2	3	3	0	1	1	0	2	**0**
Total	**1479**	**1907**	**1784**	**1917**	**2034**	**2140**	**2860**	**2844**	**2054**	**2864**	**3103**	**3291**	**4513**

In 2024, the total number of occurrences has increased by 37% over 2023. The analysis by Safety Issues, covered later on in this report, will highlight the main reasons for this significant increase.

In the national occurrence database, 11405 individual entries were recorded for 2024, consisting of 5047 original reports and 6358 follow-up reports. 534 of the 5047 original reports were duplicates, i.e. reports by another organisation of the same event. With duplicate reports being merged into one, a total of 4513 occurrences remains.

Analysis methodology

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. The Safety Issues have been defined empirically, based on the actual reported occurrences, and are stable since a long time, allowing year-on-year comparisons.

Starting in 2023, the use of a new risk classification scheme has become mandatory for DAC and all other national aviation authorities of the European Union. The European Risk Classification Scheme (ERCS, see Annex II) uses a very big risk matrix. 2024 being only the second year where this methodology is used, it was found that the distribution of occurrences across the ERCS matrix differed from 2023. The analysis for 2024 was therefore mainly based on the total number of occurrences related to a Safety Issue, and the risk classification of each occurrence was treated with caution.

Main Safety Issues

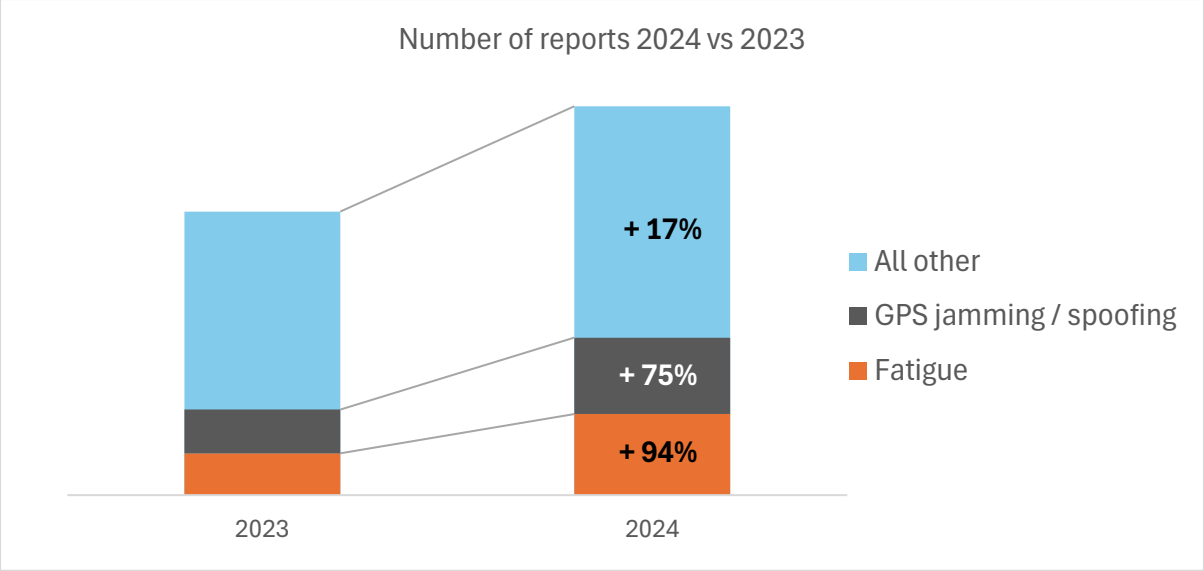
The three most important Safety Issues for 2024 are unchanged from 2023. They are, in no particular order:

- **Fatigue,**
- **GPS jamming and spoofing,**
- **Risk of Mid-air collision.**

Fatigue and Risk of Mid-air collision were already in the top two positions of many previous years.

The highest numbers of reports by far are Fatigue and GPS jamming/spoofing reports. However, they are associated with a low severity. For the Risk of mid-air collision, the number of related reports is much lower but the average severity is significantly higher.

Both for Fatigue and GPS Jamming/spoofing, the number of reports has seen a huge increase in 2024. These two Safety Issues are the major contributors to the increase in the total number of reports of 2024. However, all other Safety issues together still show a 17% increase.



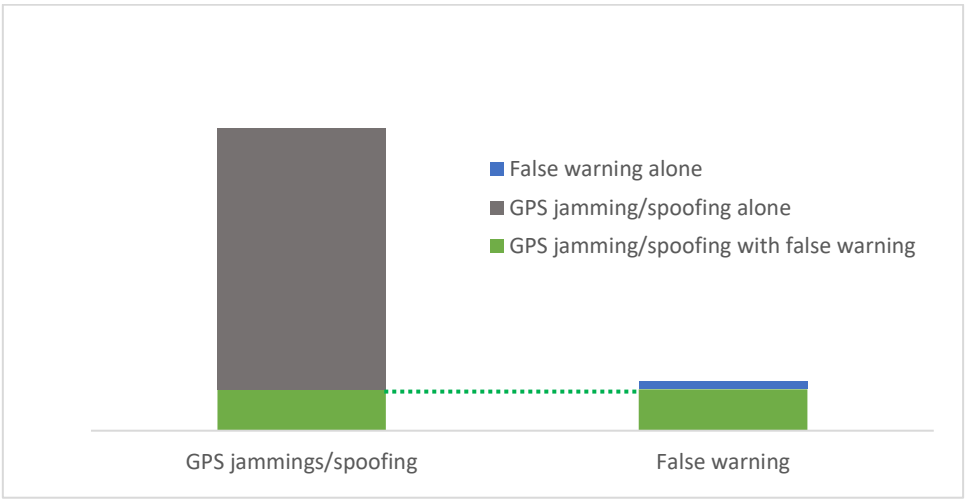
Fatigue

The very high number of Fatigue reports is driven by voluntary reports, which are forwarded to DAC since 2017. A review of past data shows that after 2018, the number of reports dropped before picking up again. The number of reports of 2023 was still below the 2017 and 2018 numbers, which were now exceeded for the first time in 2024, by a significant margin.

GPS jamming and spoofing

The effect of jamming on the aircraft systems is that it cannot determine its position using the GPS system, whereas spoofing can present a false position and/or altitude to the crew. The risk is therefore higher with spoofing, which may even involve false alerts being displayed (e.g. false EGPWS alerts). In 2024, the proportion of spoofing events was also on the rise.

Actual false alerts are tracked in another Safety issue “False warning”, and GPS spoofing events that lead to an actual false alert are assigned to both Safety issues. These cases make up for 84% of the “False warning” reports, and are responsible for a significant increase of that Safety Issue.

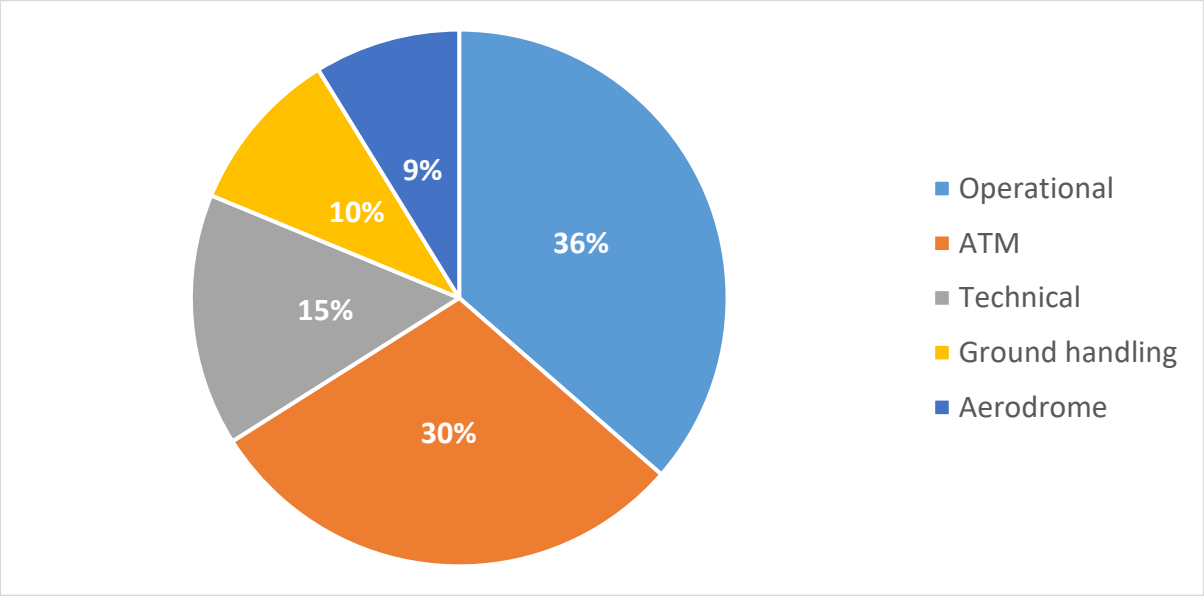


Risk of Mid-air collision

The number of related occurrences has increased by 26% overall. The increase is more pronounced for occurrences in Luxembourg than for occurrences outside of Luxembourg.

Distribution per domain

Each Safety Issue is assigned to one or more domains, which allows to calculate the distribution of occurrences across the different domains. The "Operational" and "ATM" domains together cover two thirds of all occurrences. The "Operational" domain includes the many Fatigue reports, while the "ATM" domain includes the GPS jamming and spoofing reports. Without those, the distribution would look much more even.



Operational Safety Issues

For the operations domain, the next most important Safety Issues can be ranked according to their overall number of occurrences. They are, by order of importance:

- **Incorrect aircraft setup by crew**
- **Unstabilized approach**
- **Aircraft deviation from ATC instruction**
- **Flight towards terrain (risk of CFIT)**

The Safety Issue "incorrect aircraft setup by crew" saw a significant rise in 2021 and 2022, followed by a good decrease in 2023. Unfortunately, this decrease has been reversed, and the number of reports is now higher than in 2021-2022.

The reports of unstabilized approaches show a mitigated picture. Last year the number of unstabilized approaches at Luxembourg airport was particularly high. Their number has decreased again but the number of unstabilized approaches by operators from Luxembourg at other airports has increased.

“Flight towards terrain (risk of CFIT)” usually has a very low number of associated reports, but has seen a 160% increase in 2024.

Safety Issues of other domains

Technical (Airworthiness)

The main Safety issue of this domain is “Improper installation of parts”. The high level of 2023, which could be an indication of better reporting, has been confirmed in 2024.

ATM (Air traffic management): False localizer/glideslope capture at ELLX

In November 2023, a modification of the localizer signal emission of RWY24 in Luxembourg introduced a risk of early localizer capture. The same situation was continuing in 2024, during which a much higher number of occurrences was noted than in the last 2 months of 2023. The risk was continuously monitored, and crews were informed about the risk of early capture.

Aerodrome

The number of FOD reports (foreign objects on runways, taxiways or aprons) remains high. Almost all of them originated from patrols and inspections on the lookout for FOD and are therefore considered very low risk. More noteworthy, specifically for Luxembourg airport, is the increasing trend of vehicle traffic violations on the apron and the internal vehicle road that could lead to a conflict with aircraft.

Ground handling

Issues originating from the ground handling tasks of towing, marshalling and chocks are collected in one Safety Issue. The number of related reports has increased by almost 120% over 2023. A majority of the reports are from Luxembourg airport, but the increase is observed for both Luxembourg and other airports.

Other significant trends

After presenting the most important Safety Issues, it is also interesting to determine which other Safety Issues showed a significant trend.

Improvements have been noted for:

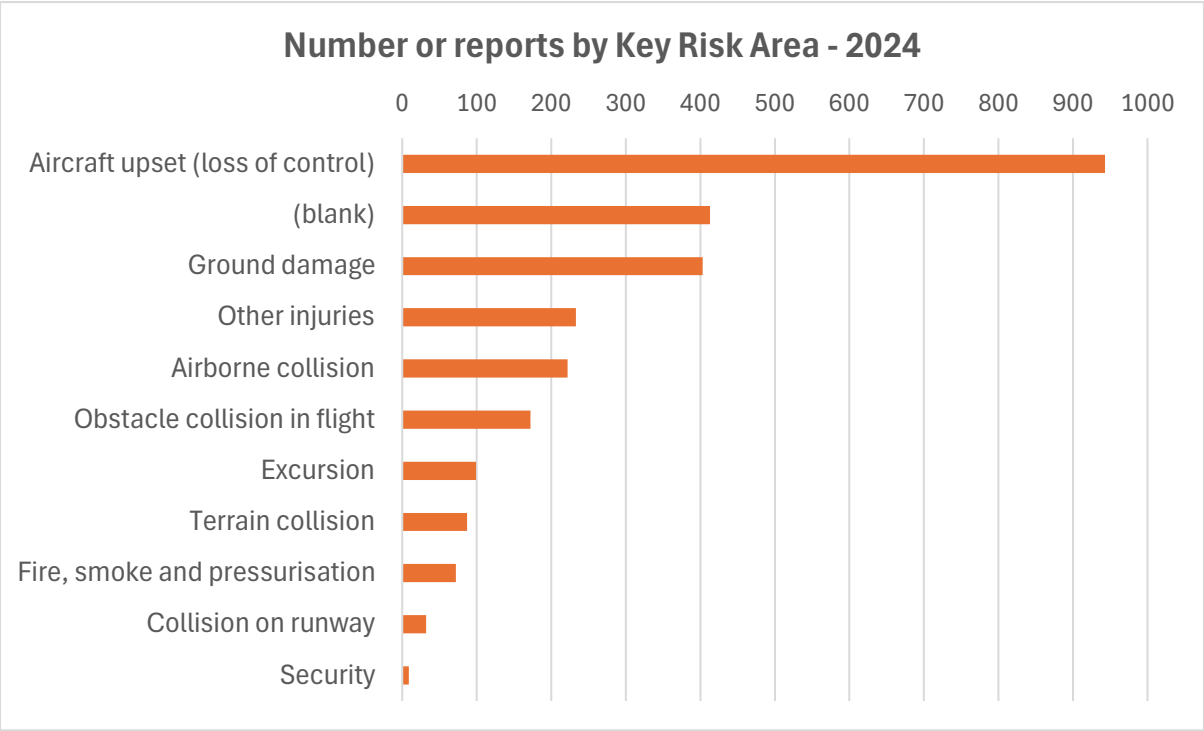
- Level bust/ altitude bust
- Door not secure
- Technical – flight controls

Analysis by Key Risk Areas

Within the ERCS methodology (see Annex II), the Key Risk Area (KRA) represents the type of potential accident outcome that is the most probable. Each occurrence is linked to only one of the 10 Key Risk Areas:

Airborne collision
Aircraft upset (loss of control)
Collision on runway
Excursion
Fire, smoke and pressurisation
Ground damage
Obstacle collision in flight
Other injuries
Security
Terrain collision

While some occurrences are very easy to assign to one KRA, it can be more difficult for other occurrences to select one KRA over another. In particular, the occurrences related to Fatigue and to GPS jamming and spoofing do not directly fit in one obvious KRA. As a very high number of reports is linked to these Safety Issues, the following analysis excludes these reports.



The most represented KRA by far is “Aircraft upset (loss of control)”. A wide range of very different Safety Issues is represented here, varying from crew factors like incorrect aircraft setup by crew, environmental factors like turbulence, to a number of different airworthiness issues. False glideslope capture is also represented here because, in the specific issue that was encountered at ELLX, the false signal will disappear as the aircraft starts to descend along the signal, making a terrain collision unlikely.

The KRA is left blank for occurrences that could not lead directly to any of the other KRAs without a significant additional event. This is mostly the case for a subset of ATM-related issues, especially ATM technical issues with the surveillance or IT equipment.

The KRA “Ground damage” is made up of the large number of FOD reports, the occurrences related to towing, marshalling and chocks, as well as other ground-handling related occurrences.

Conclusion

The first conclusion for aviation safety in Luxembourg in 2024 is that it was another safe year with no accidents and no serious incidents.

The three main Safety Issues remain unchanged from 2023:

- Fatigue,
- GPS jamming and spoofing,
- Risk of Mid-air collision.

All three have seen an increase of reported events in 2024. For Fatigue and GPS Jamming and spoofing, the increase is really significant. Relevant actions for these risks, as well as for other risks identified through other information sources, are defined in the 2024 Update of the National Plan for Aviation Safety (NPAS)[1].

The analysis by Key Risk Area shows that the KRA "Aircraft upset (loss of control)" exceeds the other nine Key Risk Areas by far. A wide range of different Safety Issues is contributing to this KRA.

The big overall increase, by 37%, of the number of occurrences is not entirely explained by the increase of the Fatigue and GPS jamming and spoofing Safety Issues. For other Safety Issues as well, more occurrences have been reported. Overall, this demonstrates that it is important to remain vigilant and to pay attention to a variety of safety risks.

[1] npas-update-2024.pdf

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: ERCS Methodology

Since January 2023, the application of the European Risk Classification Scheme (ERCS) is mandatory for all national aviation authorities of the European Union.

In the ERCS Matrix, an occurrence is assigned a severity score X,S,M,I,E or A (vertically in the matrix below) and a probability score 0-9 (horizontally, 0 for actual accidents).

SEVERITY			CLASSIFICATION									
Potential Accident Outcome	**Score**	**Points**										
Extreme catastrophic accident with significant potential fatalities (100+)	X	*1000000*	X/9	X/8	X/7	X/6	X/5	X/4	X/3	X/2	X/1	X/0
			1.00E-03	0.01	0.10	1	10	100	1,000	10,000	100,000	1,000,000
Significant accident with significant potential for fatalities and injuries (20-100)	S	*500000*	S/9	S/8	S/7	S/6	S/5	S/4	S/3	S/2	S/1	S/0
			5E-04	5E-03	0.05	0.5	5	50	500	5,000	50,000	500,000
Major accident with potential for some fatalities/life changing injuries (2-19) or major aircraft destroyed	M	*100000*	M/9	M/8	M/7	M/6	M/5	M/4	M/3	M/2	M/1	M/0
			1E-04	1E-03	0.01	0.1	1	10	100	1,000	10,000	100,000
Single Individual fatality/life changing injury or substantial damage accident	I	*10000*	I/9	I/8	I/7	I/6	I/5	I/4	I/3	I/2	I/1	I/0
			1E-05	1E-04	1E-03	0.01	0.1	1	10	100	1,000	10,000
Minor and Serious Injury (not life changing) accidents and Minor Damage	E	*1000*	E/9	E/8	E/7	E/6	E/5	E/4	E/3	E/2	E/1	E/0
			1E-06	1E-05	1E-04	1E-03	0.01	0.1	1	10	100	1,000
	A	*0*	A/0									
		Score	9	8	7	6	5	4	3	2	1	0
		Barrier Score	17-18	15-16	13-14	11-12	9-10	7-8	5-6	3-4	1-2	0
		Ref Value	1.E-09	1.E-08	1.E-07	1.E-06	1.E-05	1.E-04	1.E-03	1.E-02	1.E-01	1.E+00
		PROXIMITY TOWARDS ACCIDENT OUTCOME										

First, the Key Risk Area (KRA) of an occurrence is determined. It represents the type of potential accident outcome, for example “collision on runway”.

The severity score is determined by the potential loss of life, taking into account the passenger capacity of the involved aircraft. For cargo aircraft, the ERCS methodology is assigning the same passenger capacity (and therefore the same risk) as the equivalent-size passenger aircraft. Note that, for the analysis underlying this report, an adjustment of the methodology was used where the ERCS scores have been modified to represent the real occupant capacity of cargo aircraft.

The probability score represents the probability or likelihood of the assessed occurrence escalating into an accident outcome. It is determined by an assessment of the effectiveness of all the “safety barriers” that remained in place in the actual occurrence. A barrier model with 8 barriers (3 systemic barriers and 5 operational barriers) is used.

Very often, is it not obvious from the initial report which safety barriers worked as intended, which ones were still “in reserve” and which ones failed. Therefore, follow-up reports from the reporting organisations are crucial for DAC to understand these elements. The information contained in follow-up reports is a key enabler for a realistic ERCS risk classification of occurrences and for a valid analysis.

Further information about the ERCS methodology can be found here:

[Aviation Safety Reporting | EASA]