



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 2023

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Accidents and serious incidents

In 2023, aviation operators from Luxembourg were involved in two accidents, but no serious incidents. Both accidents, one of which concerned Commercial Air Transport, happened in Luxembourg.

The investigation by the Administration des Enquêtes Techniques (AET) into the accident of 14.5.2023 is ongoing and has produced a preliminary report¹ in August 2024.

	Aircraft type	Date	Location	Event	Investigation
Accident	n/a	15.4.2023	ELNT Noertrange	Parachute hard landing	n/a
Accident	Boeing 747-400	14.5.2023	ELLX Luxembourg	Landing gear separation	AET

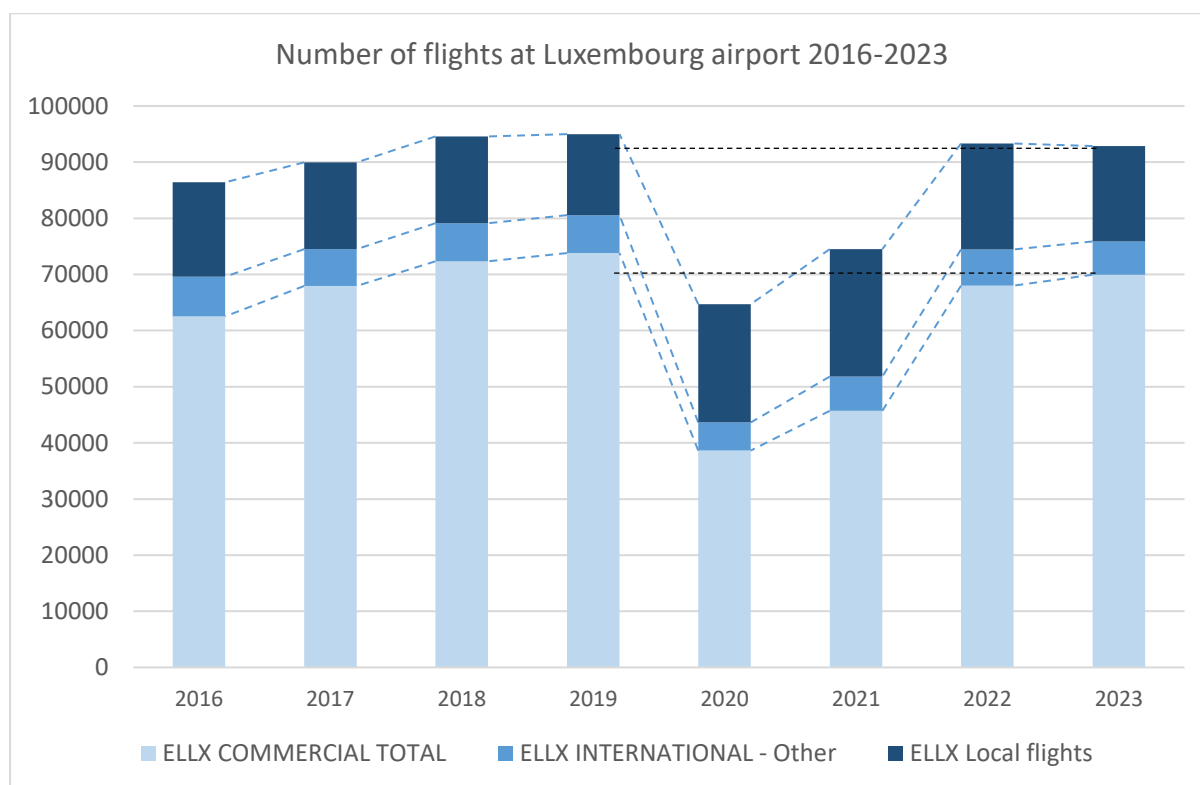
Although it is the first time in 5 years that more than one accident was recorded, over the longer term the number of accidents still shows a decrease. The number of serious incidents is very low and more or less stable. Although both the numbers of accidents and serious incidents are very low, they do not display the usual distribution: Serious incidents are generally more frequent than accidents.

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

¹ [Righthand Body Landing Gear separation during landing of a Boeing B747-4R7F registered LX-OCV and operated by Cargolux Airlines International S.A. on runway 06 at Luxembourg Airport \(ELLX\) on 14 May 2023](#)

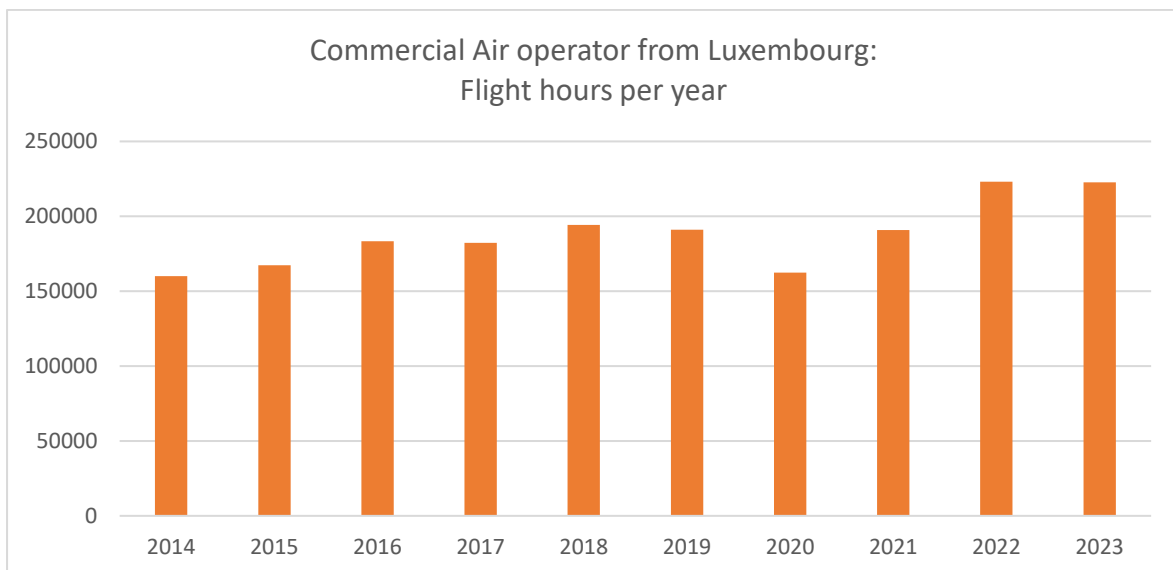
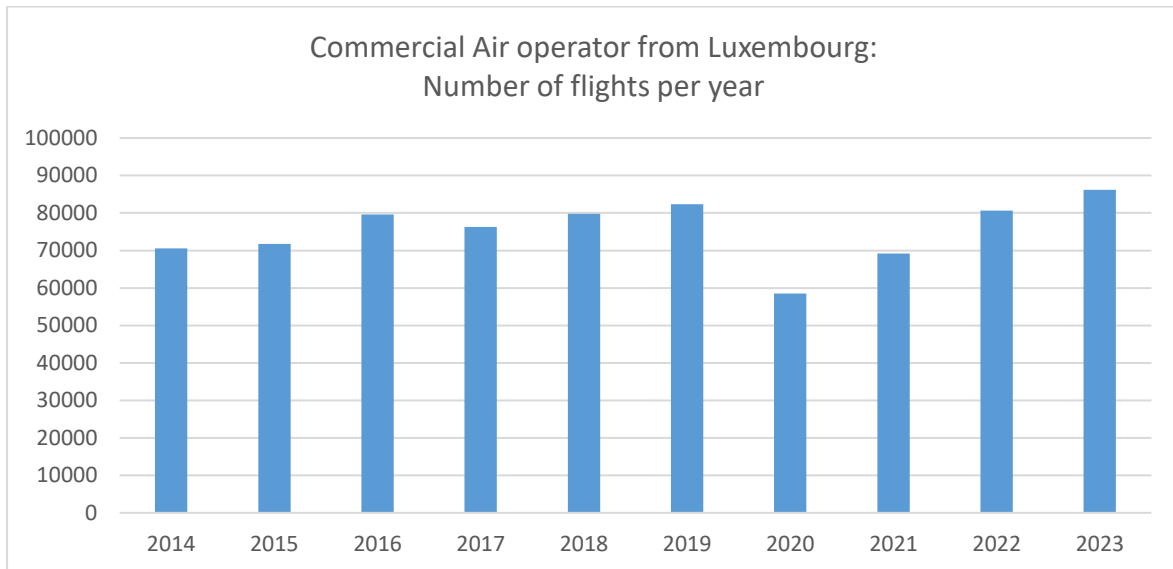
Evolution of traffic

The overall traffic at Luxembourg airport is relatively stable, after recovering in 2022 from the significant reduction caused by the pandemic. An increase in commercial traffic is compensated by a decrease in other international traffic and local traffic, resulting in a very small overall reduction. Commercial traffic has not quite yet reached the level of 2019.



Source data: Administration de la Navigation aérienne

Regarding air operators certified in Luxembourg, their total number of flights (worldwide) has increased by 7% over 2023 and has surpassed the previous maximum of 2019. However, the total of flights hours has not increased over 2022, which is due to shorter flights on average for a part of the commercial fleet.





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

The total number of occurrences has increased by 6% over 2022. This shows the continuing well established reporting culture.

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.

Since 2014, the Annual Safety Reports of DAC have presented a “Top Ten” of the Safety Issues. The ranking was based on the ARMS methodology (see Annex II), where a numerical “Risk index” is assigned to each occurrence. Although the numerical values had to be considered with some caution, the sum of the Risk indexes of the occurrences associated to each Safety Issue provided an indicative ranking of the Safety Issues.

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 III) uses a different approach, as well as a much bigger risk matrix. Although the ERCS methodology also assigns numerical values for risk to each occurrence, their sum is not used for comparison due to their extreme span between very large and very small numbers. Instead, the following factors were considered for the analysis per Safety Issue, arbitrated by expert judgment:

- The total number of occurrences related to a Safety Issue
- The number of related “Yellow” or “Red” occurrences

A purely numerical “Top Ten” ranking being no longer feasible, a different approach had to be developed. Unfortunately the direct comparison to previous years is also lost, making the identification of trends more difficult. While the total number of occurrences can be easily compared to the previous year, a comparison of the “severity” can at best be based on the green/yellow/red color coding which is common to both methodologies. However, the relative distribution of the occurrences shows that there is no direct match between the two methodologies, and caution needs to be used for this comparison.

% of occurrences	2022	2023
	ARMS methodology	ERCS methodology
Red	0%	0%
Yellow	19%	8%
Green	58%	62%
Green – No accident outcome	23%	30%

Main Safety Issues

The three most important Safety Issues for 2023, in no particular order, are:

- **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 the “Top Ten” of many previous years. As in previous years, there is a large number of fatigue reports of low risk on average. Its number has also significantly increased over 2022.

The evolution of the number of reports related to the Safety Issue Risk of Mid-air Collision shows a decrease during the pandemic years 2020-2021, but in 2023 it reached a similar level to 2019.

GPS jamming and spoofing is a Safety Issue that is on a significant rise: the number of occurrences more than doubled between 2022 and 2023. While the occurrences are generally of low severity, their number is the highest among all Safety Issues in 2023. Jamming means that the aircraft’s systems 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). The number of spoofing events is also on the rise.

Operational Safety Issues

For the operations domain, the next most important Safety Issues can be ranked according to their overall number of occurrences as well as the number of “yellow” occurrences (no “red” occurrences involved). They are, by order of importance:

- **Unstabilized approach**
- **Incorrect aircraft setup by crew**
- **Aircraft deviation from ATC instruction**
- **Level bust / Altitude bust**

The number of unstabilized approaches has increased by almost 70% over 2022 and their average severity has increased as well. Surprisingly, the increase is almost entirely for approaches to Luxembourg airport: 45% of all unstabilized approaches of 2023 occurred at Luxembourg airport, compared to 19% in 2022. This is unrelated to the glideslope issues that will be discussed later in this report. The meteorological seasons also seem to have no significant impact, as only a small increase is seen for the months of November and December.

For the Safety Issue related to incorrect aircraft setup by crew, significantly less reports were received than in 2022. However, the average severity has increased as more reports were classified as “yellow”.

The number of aircraft deviation from ATC instruction is stable. This Safety Issue was included in the “Top Ten” of previous years.

Level bust / Altitude bust was not included in the "Top Ten" since 2019. The number of related occurrences peaked in 2019, then decreased. In 2023 the number increased significantly and even exceeded the peak of 2019.

Technical Safety Issues

Improper installation of parts

This Safety Issue shows an overall increase of more than 100%, however, they are on average of lower severity than in 2022. This could be an indication of better reporting.

Engine failure or problems - multi-engine aircraft

This Safety Issue shows a significant decrease.

Specific safety issues in Luxembourg

False localizer/glideslope capture

In November 2023, a modification of the localizer signal emission of RWY24 in Luxembourg was introduced. While it is mitigating the risk of interference from construction cranes on the localizer signal, a secondary effect of this modification was the risk of early localizer capture. Early localizer capture has been assessed as the less severe risk because it will disappear as the aircraft descend lower. The same situation is ongoing in 2024 but is being monitored and crews are informed about the risk of early capture. Nevertheless, it shows up in this analysis as the most significant of the specific safety issues at Luxembourg airport.

CNS issues

The number of reports related to ATM technical equipment (Communication, Navigation, Surveillance) remained stable, although their distribution changes: Flight Data Processing (FDP) systems had less issues, but this improvement was counteracted by other components.

FOD

In 2021 and 2022, while runway refurbishment works were ongoing, a very high number of FOD reports was noted. Almost all of them originated from patrols and inspections on the lookout for FOD. In 2023, without any large-scale runway works, the number of reports decreased significantly.

Other significant trends

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

A deteriorating trend has been noted for crew incapacitation (flight crew and cabin crew).

Improvements have been noted for:

- Birdstrikes
Compared to 2022, the number of birdstrikes reported by Luxembourg operators decreased by 21% at Luxembourg airport and by 49% at airports outside Luxembourg.
- Jet blast / propeller hazard
- ATC coordination issue (between 2 different ATC units)
- Fuel imbalance

Conclusion

The transition to the new ERCS methodology for risk classification of occurrences made the data analysis more difficult. For trend analysis in particular, a return to more basic elements, like comparing the number of reports and a simple red/yellow/green severity classification, became necessary. Nevertheless, the analysis reveals that the high safety level of aviation in Luxembourg has been maintained.

Crew fatigue and the risk of Mid-air Collision remain the highest risks, but are now joined by GPS jamming and spoofing.

This report considers the risks identified through reporting of safety occurrences. Thanks to a good reporting culture, this remains a valid source. The previous Annual Safety Report provided valuable input for the 2024 update of the National plan for Aviation Safety² (NPAS). The NPAS considers other sources as well, including input from aviation stakeholders. It therefore identifies some additional risks, in particular more systemic risks. It addresses for example the effectiveness of Safety Management Systems (SMS) and of root cause analysis, including root cause analysis applied to safety occurrences. The reporting operator is best placed to perform a detailed analysis and to implement valid safety actions adapted to his operations.

² [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: ARMS Methodology

Up to 2022 included, DAC used the Aviation Risk Management Solutions (ARMS) 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”. In total, DAC is currently tracking more than 120 potential Safety Issues.

Annex III: 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, it is 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](#)