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 2014

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.

The 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.

2. Occurrences

a. Accidents and serious incidents

In 2014, neither commercial aviation in Luxembourg nor air operators from Luxembourg were affected by accidents. Five accidents have been recorded in General Aviation, affecting aircraft registered in Luxembourg. No injuries or fatalities resulted from these accidents, all of them were limited to material damage.

	Date 2014	**Location**	**Event**	**Consequences**	**Investigation**	**CICTT Categories** (provisional)
Single engine piston	24/02	ELLX Luxembourg	Runway excursion upon landing	Aircraft damaged	Ongoing (AET)	ARC, LOC-G, RE
Home-built aircraft	04/03	LF5422 Micheville (F)	Engine failure during take-off followed by crash	Aircraft destroyed	none	SCF-PP, ARC, LOC-G
Home-built aircraft	30/03	LFAV Villerupt (F)	Collision with obstacle during taxi	Aircraft damaged	none	GCOL
Single engine piston	19/05	Near Ottange (F)	A/C crashed during emergency landing training	Aircraft damaged	Closed BEA France	LALT, LOC-I
Single engine piston	29/05	ELLX Luxembourg	Bounced landing and runway excursion	Aircraft damaged	Ongoing (AET)	TURB, ARC, RE

Only one serious incident has been reported in 2014 by an operator from Luxembourg: a hard landing in Libreville (Gabon) on November 24, 2014. This event is currently under investigation by the Administration des Enquêtes Techniques (AET) of Luxembourg, by delegation from the Gabonese authorities.

The definitions of accident, incident and serious incidents are shown in annex to this document.

b. 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. 1784 occurrences have been reported in 2014 (separate reports by different actors concerning the same event have been merged into one occurrence).

The number of reports is slightly lower than in 2013. However the decrease only affects the categories of lowest severity: proactive reports and occurrences without safety effect. The number of incidents is slightly higher than in 2013. The increase can be seen in relation to the slight increase in traffic, but also in relation to better reporting by maintenance personnel and ground handling personnel.

	2012	2013	Variation 2012-2013	2014	Variation 2013-2014
Proactive report	332	561	*+69%*	**454**	***-19%***
Occurrence without Safety Effect	684	813	*+19%*	**727**	***-11%***
Incident	458	523	*+14%*	**597**	***+14%***
Serious Incident	3	1		**1**	
Accident	2	9		**5**	
Total	1479	1907	*+29%*	**1784**	***-6%***

c. Occurrence categories

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

*(CAST/ICAO Common Taxonomy Team)

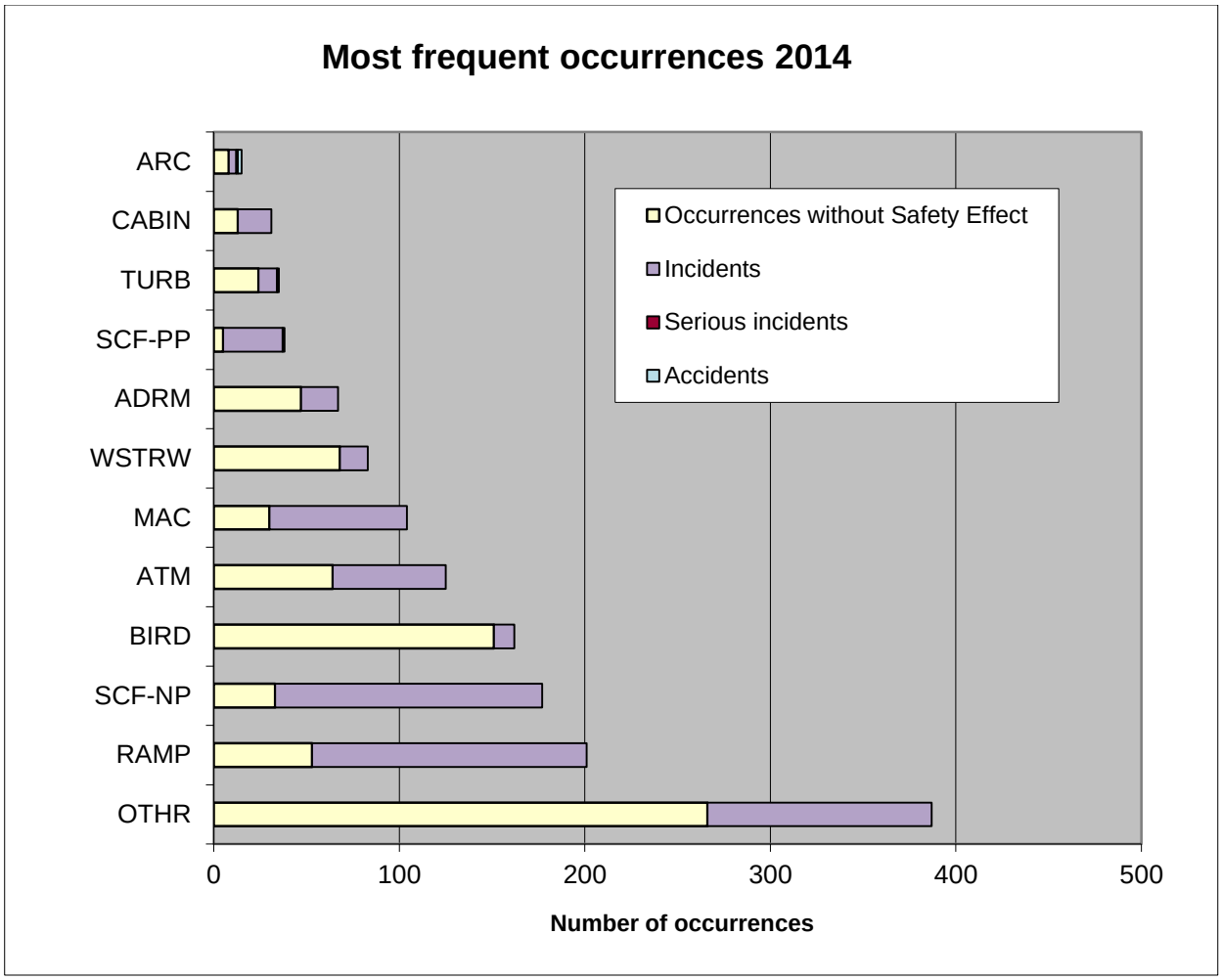


Chart No.1: Most frequent occurrences of 2014, by category

Description of categories:

ARC:	Abnormal runway contact
CABIN:	Miscellaneous occurrences in the passenger cabin of transport category aircraft
TURB:	In-flight turbulence encounter
SCF-PP:	Failure or malfunction of an aircraft system or component - related to the powerplant
ADRM:	Occurrences involving aerodrome design, service, or functionality issues
WSTRW:	Flight into windshear or thunderstorm
MAC:	Airprox, ACAS alerts, loss of separation as well as near collisions or collisions between aircraft in flight
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
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
OTHR:	Any occurrence not covered under another category

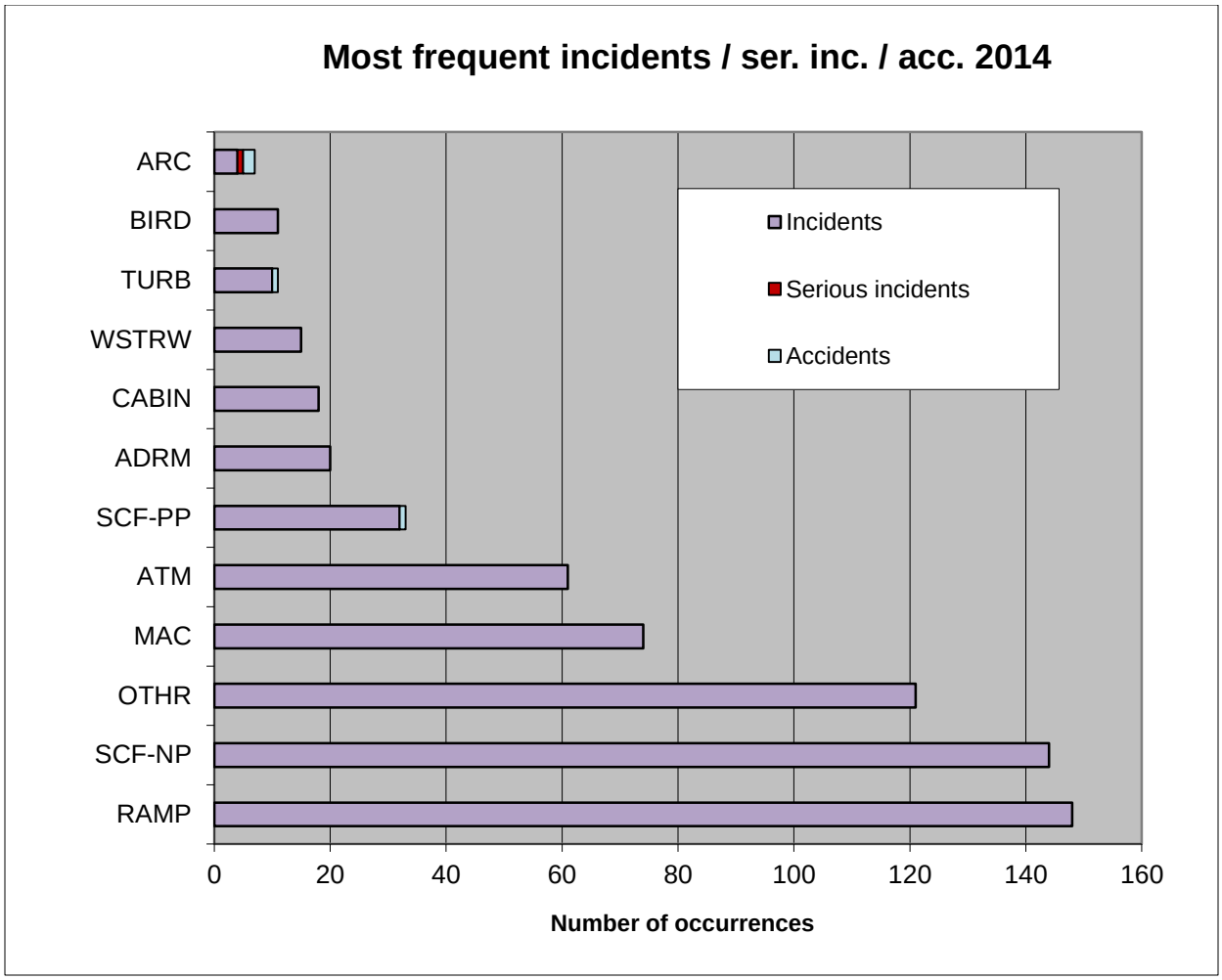


Chart No. 2 : Most frequent Incidents / Serious incidents / Accidents of 2014, by category

Chart No.2 is focusing on occurrences which had a safety impact (classified as incidents, serious incidents and accidents). The categories RAMP (ground handling) and SCF-NP (technical failures not related to the powerplant) are in first and second place. Moreover, the trend of the number of occurrences over 18 months (Chart No. 3) shows an increase in the number of ground-handling related occurrences (RAMP). This increase is likely related to better reporting of occurrences by ground handling personnel rather than a deterioration of safety. Nevertheless, the high number of incidents shows that this domain is of high importance. Due to the large variety of tasks and associated risks, a breakdown into separate potential "safety issues" will allow a more detailed analysis.

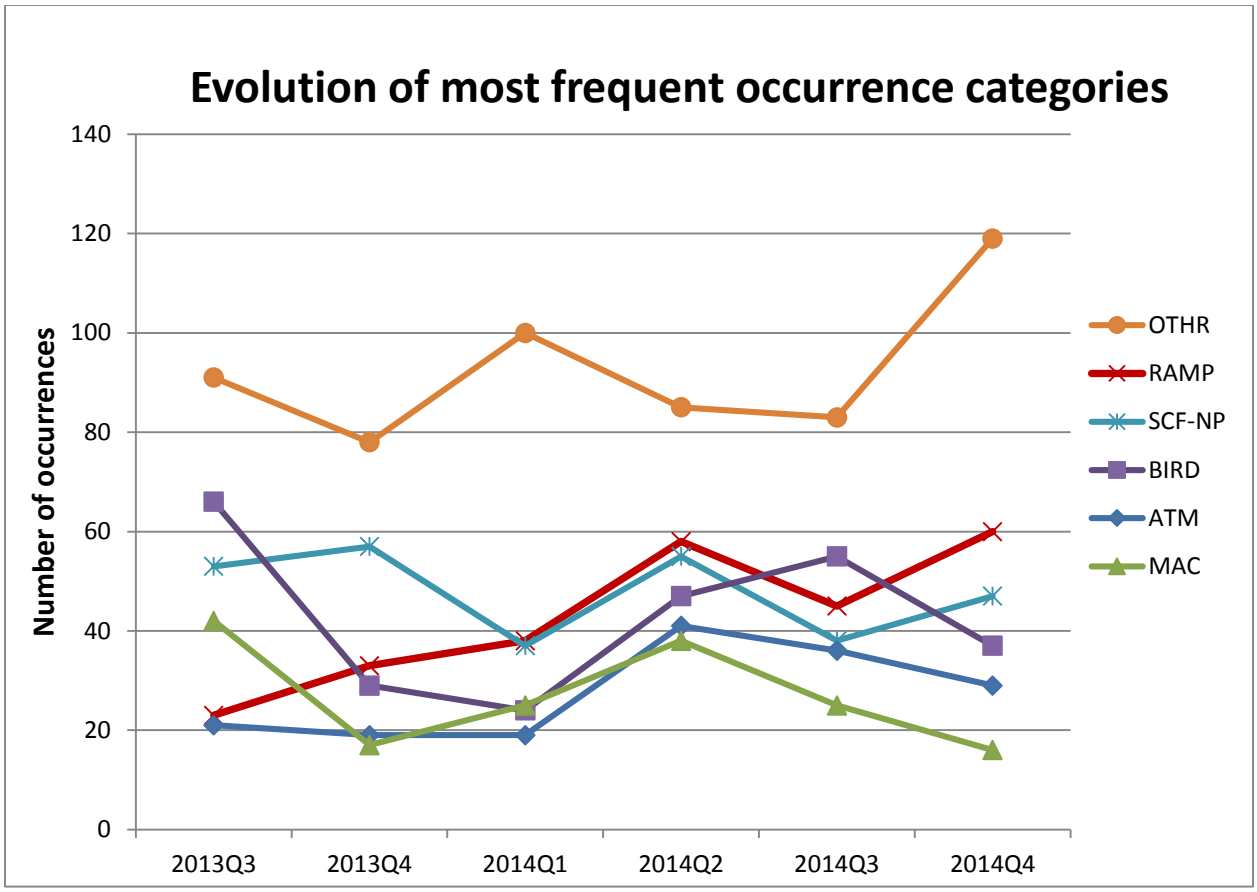


Chart No. 3: Number of occurrences per trimester, by category

3. Safety issues

a. Identification of potential safety issues

For every occurrence, the DAC assigns an "ERC risk index" according to the ARMS methodology. The 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 according ARMS.

Source: The ARMS Methodology for Operational Risk Assessment in Aviation Organisations. Developed by the ARMS Working Group, 2007-2010

The occurrence is then 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 "potential safety issue", a new potential safety issue is created, in order to be able to identify future recurring events.

b. Risk assessment and classification of potential safety issues

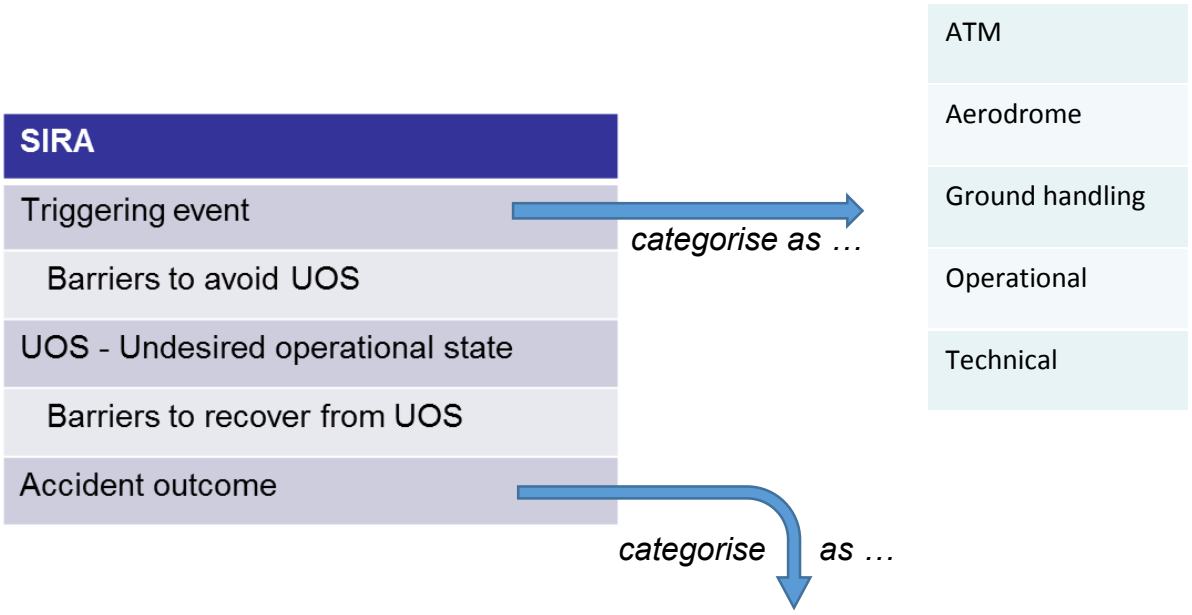
The risk assessment (« SIRA – Safety Issue Risk Assessment ») according to the ARMS methodology, allows to identify:

- 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, 98 potential safety issues are currently being tracked (status June 2015). 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 have been defined, corresponding to the "feared consequences" of the risk portfolio of DGAC France*.

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



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

4. Identified safety issues

a. « Top 10 » safety issues

Each safety issue is linked to a number of occurrences with their associated risk index number. So it is possible to determine the most important safety issues by comparing the sum of the risk index numbers associated with each safety issue. The 10 most important safety issues are:

	SAFETY ISSUE TITLE	Accident Severity	Potential accident outcome						
			CFIT	LOC-I	MAC	GCOL	Runway excursion	Injury or damage in flight	Injury or damage on ground
1	Cargo moving/shifting during flight	Catastrophic		X			/	X	
2	Risk of MAC	Catastrophic			X				
3	Loss of control during landing **GENERAL AVIATION**	Major		/			X		X
4	Airspace infringement	Catastrophic			X				
5	Hard landing	Major					X		X
6	Handling of Dangerous Goods	Catastrophic		X				X	
7	Mismatch between calculated and actual CG	Catastrophic		X			X		
8	Level bust / Altitude bust	Catastrophic	X		X				
9	Engine failure or problems - single engine aircraft **GENERAL AVIATION**	Major	/	X			X		
10	Aircraft released with incomplete maintenance tasks	Catastrophic	/	X		/	X	X	X

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

/ : the safety issue can exceptionally lead to the potential accident outcome

Note : safety issues linked to a "minor" accident severity have been excluded for the Top Ten

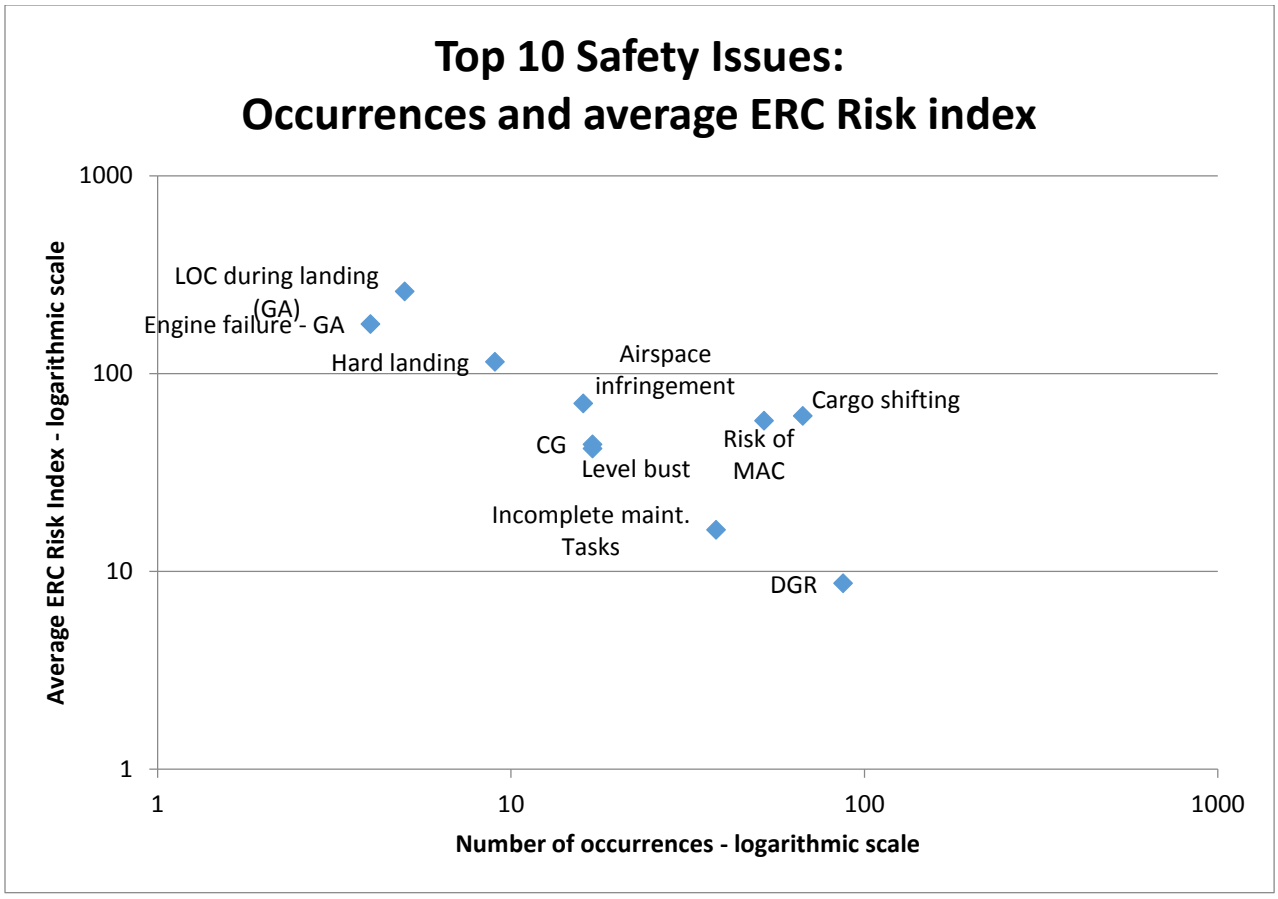


Chart No. 4: Number of occurrences and average risk index linked to the Top Ten safety issues

Chart No. 4 shows the distribution of the Top Ten safety issues between a small number of high risk occurrences and a high number of occurrences with a lower average risk index.

In the next sections, the Top 3 safety issues will be presented for each of the identified domains of triggering events.

b. Operations

TOP 3 OPERATIONAL SAFETY ISSUES			Accident outcomes						
	SAFETY ISSUE TITLE	**Accident Severity**	**CFIT**	**LOC-I**	**MAC**	**GCOL**	**Runway excursion**	**Injury or damage in flight**	**Injury or damage on ground**
1	Risk of MAC	Catastrophic			X				
2	Airspace infringement	Catastrophic			X				
3	Hard landing	Major					X		X

The risk of mid-air collision is related to various causes. Some of the occurrences assigned to this safety issue are assigned in parallel to other safety issues such as level bust or airspace infringement.

c. Ground handling

TOP 3 GROUND HANDLING SAFETY ISSUES			Accident outcomes						
	SAFETY ISSUE TITLE	**Accident Severity**	**CFIT**	**LOC-I**	**MAC**	**GCOL**	**Runway excursion**	**Injury or damage in flight**	**Injury or damage on ground**
1	Cargo moving/ shifting during flight	Catastrophic		X			/	X	
2	Handling of Dangerous Goods	Catastrophic		X				X	
3	Mismatch between calculated and actual CG	Catastrophic		X			X		

A high risk is associated with cargo moving or shifting during flight, which affects the center of gravity of the aircraft. Handling of dangerous goods appears in second place. The issue of the calculation of mass and center of gravity not matching reality can be caused by weighing errors, calculation errors or loading errors (where the actual loading does not match the loadsheet). While there are multiple sources of potential errors, the means to detect, and especially to recover from them, are limited.

d. Air traffic management

TOP 3 ATM-RELATED SAFETY ISSUES			Accident outcomes						
	SAFETY ISSUE TITLE	**Accident Severity**	**CFIT**	**LOC-I**	**MAC**	**GCOL**	**Runway excursion**	**Injury or damage in flight**	**Injury or damage on ground**
1	Risk of MAC	Catastrophic			X				
2	ATC coordination issue (between 2 different ATC units)	Catastrophic			X				
3	Runway incursion by aircraft	Catastrophic		/		X	X		

The risk of mid-air collision is associated with the ATM domain as well as the "operational" domain. A number of occurrences has also been attributed to coordination issues between two separate Air Traffic Control units.

e. Airworthiness

TOP 3 TECHNICAL SAFETY ISSUES			Accident outcomes						
	SAFETY ISSUE TITLE	**Accident Severity**	**CFIT**	**LOC-I**	**MAC**	**GCOL**	**Runway excursion**	**Injury or damage in flight**	**Injury or damage on ground**
1	Aircraft released with incomplete maintenance tasks	Catastrophic	/	X		/	X	X	X
2	Improper installation of parts	Catastrophic		X				X	X
3	Technical - flight controls	Catastrophic		X		/	X	X	X

The main airworthiness issue is the release of an aircraft while maintenance tasks have either not been executed at all, or have been started but not completed. Some steps or complete tasks can be forgotten, especially when coordination between several actors is required.

f. Aerodrome

TOP 3 AERODROME-RELATED SAFETY ISSUES			Accident outcomes						
	SAFETY ISSUE TITLE	**Accident Severity**	**CFIT**	**LOC-I**	**MAC**	**GCOL**	**Runway excursion**	**Injury or damage in flight**	**Injury or damage on ground**
1	Vehicles cutting off aircraft at ELLX entering/exiting apron	Major				X			X
2	Runway or taxiway incursion by vehicle at ELLX	Major				X	/		
3	Obstacles in aerodrome surroundings	Catastrophic	X				/	/	

The two most important issues are related to vehicle traffic at Luxembourg airport. The first issue is the risk of collision between an aircraft entering or exiting the apron and a vehicle driving on the internal road. The second issue concerns runway and taxiway incursions by vehicles.

g. General aviation

TOP 3 GENERAL AVIATION SAFETY ISSUES			Accident outcomes						
	SAFETY ISSUE TITLE	**Accident Severity**	**CFIT**	**LOC-I**	**MAC**	**GCOL**	**Runway excursion**	**Injury or damage in flight**	**Injury or damage on ground**
1	Loss of control during landing	Major		/			X		X
2	Engine failure or problems – single engine aircraft	Major	/	X			X		
3	Hot Air balloon failed landing	Major		/		X			X

The accidents and incident related to loss of control during landing affecting single-engine general aviation aircraft are not probably limited to Luxembourg, they may be part of a European trend.

h. Distribution of risk

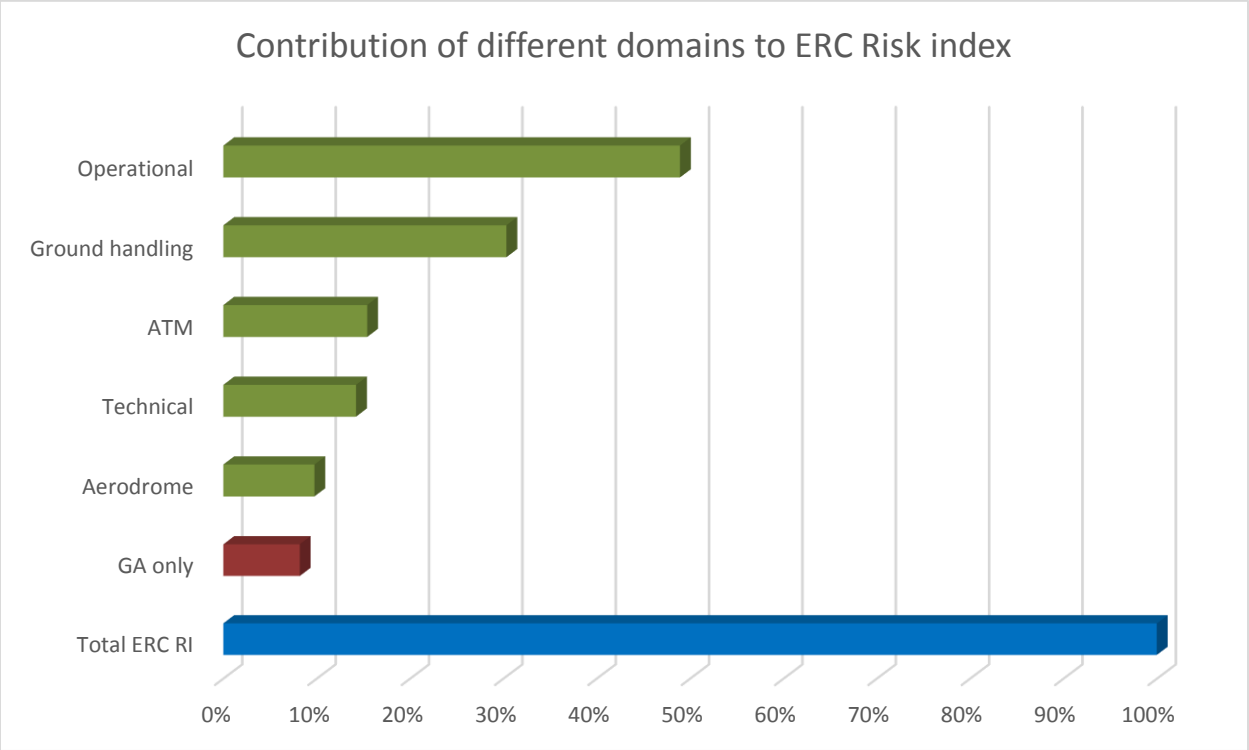


Chart No. 5: Distribution of the sum of ERC Risk indexes by domain of triggering event

Triggering events in the Operations and Ground Handling domains contribute significantly to the total risk. The sum of the contributions of the different domains exceeds 100% because a number of safety issues are associated with two or more domains (100% represents the sum of the Risk indexes of all occurrences reported in 2014).

8% of the total is related to safety issues specific to general aviation.

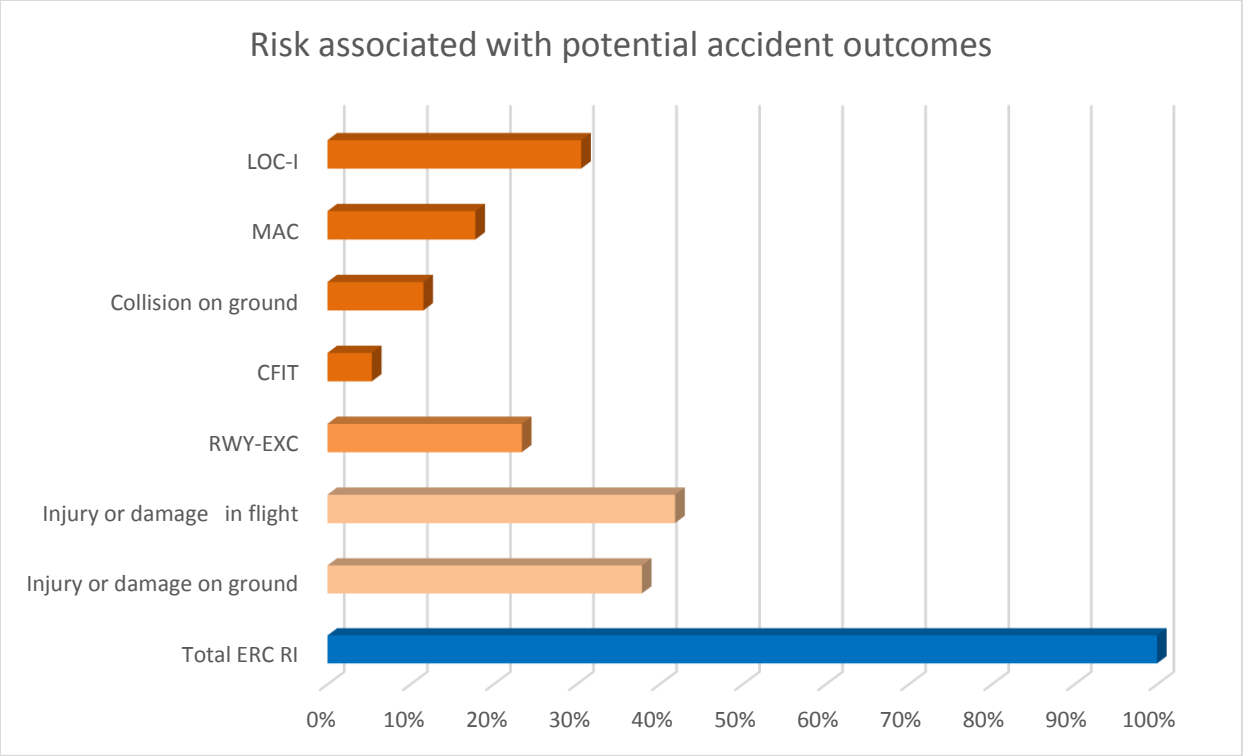


Chart No. 6: Distribution of the sum of ERC Risk indexes by potential accident outcome.

The distribution by potential accident outcome shows that the highest percentage is associated with Loss of Control in flight, if the accident outcomes with "minor" severity are neglected (Injury or damage, in flight or on ground). Again, because a number of safety issues is associated with two or more potential accident outcomes, the sum exceeds 100%.

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.

5. State Safety Program

The framework and responsibilities for the State Safety Program have been defined in 2014 by the *Règlement grand-ducal du 18 juillet 2014 relatif au programme national de sécurité aérienne*. The DAC and the Ministry of sustainable Development and Infrastructure are working on the implementation of the missing elements, starting with the State Safety Policy.

6. Conclusions

Both the analysis by occurrence category and by safety issue demonstrate the importance of ground handling for aviation safety. Particular attention should be given to correctness of the loadsheet, loading in conformity to the loadsheet and correct securing and strapping of the cargo.

In General aviation, the emerging issue of 2014 in Luxembourg and probably in Europe is the loss of control during landing, where two accidents and several incidents have been recorded in Luxembourg.

Annex

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.