



# Direction de l'aviation civile

## Annual Safety Review 2015

### **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

Three accidents and three serious incidents were reported to DAC. Only one minor injury resulted from these accidents.

Accidents 2015:

Operator	Date	Location	Event	Consequences	Investigation
<b>Private (USA), single engine piston</b>	19/1/2015	Near Stegen (L)	Forced landing due to engine failure	Substantial damage to aircraft during forced landing	Ongoing (Administration des Enquêtes techniques)
<b>Private (Lux.), single engine piston</b>	16/7/2015	Farkashegy (Hungary)	Aircraft turned over on landing	1 minor injury, substantial damage to aircraft	Ongoing (TSB Hungary)
<b>Bombardier Q400</b>	30/9/2015	Saarbrücken	Early retraction of landing gear	Substantial damage to aircraft	Interim report (Bundesstelle für Flugunfalluntersuchung)

Serious incidents 2015:

	Date	Location	Event	Actual (potential) consequences	Investigation
<b>Pilatus PC12</b>	23/1/2015	Saint-Etienne (France)	Severe icing on final	Control difficulties (Loss of control)	Delegated by BEA France to SUST Suisse
<b>Boeing 747-400</b>	21/2/2015	Novosibirsk	Wrong rotation speed used	Stall warnings (Actual stall at very low altitude)	Cargolux
<b>Bombardier Q400</b>	14/4/2015	Luxembourg	Near miss with drone	(Collision with drone)	Ongoing (Administration des Enquêtes techniques)

The definitions of accident, incident and serious incident 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.

A significant change has been introduced late in 2015 with the entry into force of European Regulation 376/2014 on occurrence reporting. Major new elements include the obligation to forward also voluntary reports to DAC and the obligation to report in a format compatible with ECCAIRS software. In addition the previously established practice that operators themselves, through their Safety Management System (SMS), collect and analyse their own reports, has been reinforced. Reports by an individual pilot or controller should not be addressed to DAC directly but through their employer's SMS.

1917 occurrences have been reported in 2015 (separate reports by different actors concerning the same event have been merged into one occurrence).

The number of reports is higher than in 2014. The increase is noted in the two less severe categories, "proactive report/observation" and "occurrence without safety effect". This points to the conclusion that the increase is due to better reporting of those events, rather than an increase in their actual number.

Type of occurrence	2012	2013	2014	2015	Variation 2014-2015
Proactive report / Observation	332	561	454	<b>535</b>	<b>+18%</b>
Occ. Without Safety Effect	684	813	727	<b>798</b>	<b>+10%</b>
Incident	458	523	597	<b>578</b>	<b>-3%</b>
Serious Incident	3	1	1	<b>3</b>	
Accident	2	9	5	<b>3</b>	
Total	1479	1907	1784	<b>1917</b>	<b>+7%</b>

## c. Occurrence categories

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

\*(CAST/ICAO Common Taxonomy Team)

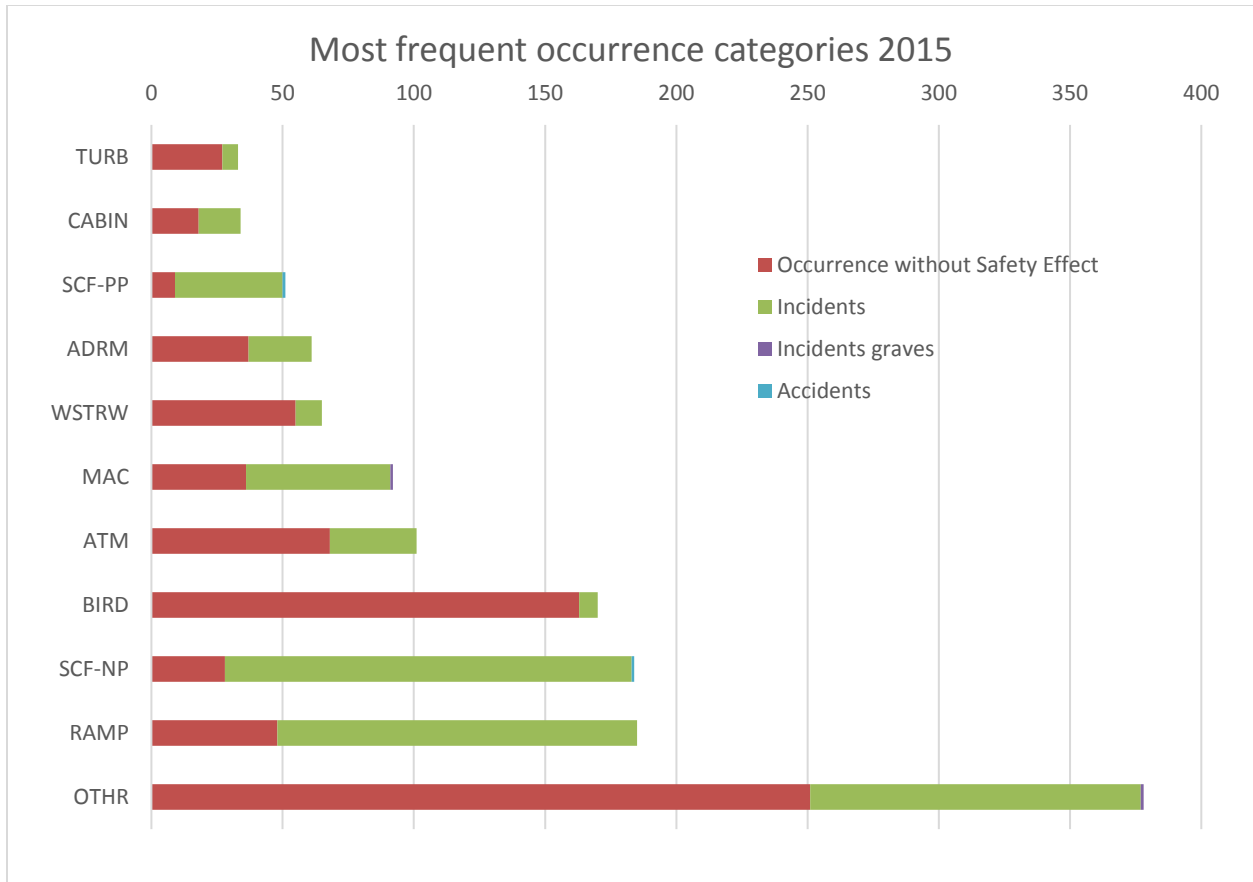
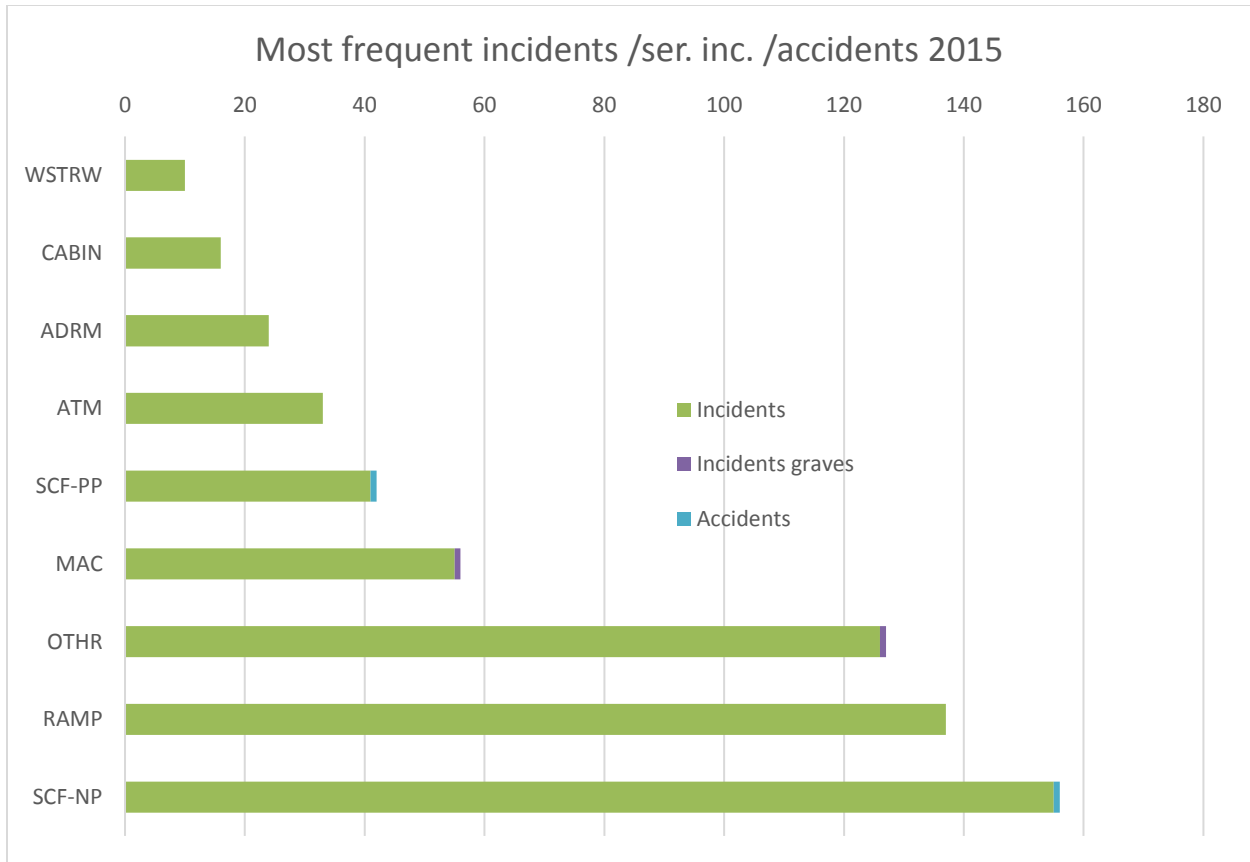


Chart No.1: Most frequent occurrences of 2015, by category

Description of categories:

- TURB: In-flight turbulence encounter
- CABIN: Miscellaneous occurrences in the passenger cabin of transport category aircraft
- 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 2015, 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.

**d. Risk classification of occurrences**

A risk classification has been applied to each occurrence, according 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*

Based on this, the sum of the ERC Risks Index numbers can be calculated for each CICTT category. The outcome is that the sum of the risk indexes for RAMP (ground handling) is higher than for SCF-NP (technical failures not related to the powerplant). Chart No. 3 represents the average of the Risk index per category vs. the number of occurrences. Logarithmic scales have been used due to the large differences between the low and high ends on both scales. The chart shows that category RAMP has the highest overall risk, having both a high number of occurrences and a high average ERC Risk Index, followed by the categories MAC (risk of mid-air collision), OTHR and SCF-NP (technical failures not related to the powerplant). The same three categories already made up the three highest risk categories in 2014.

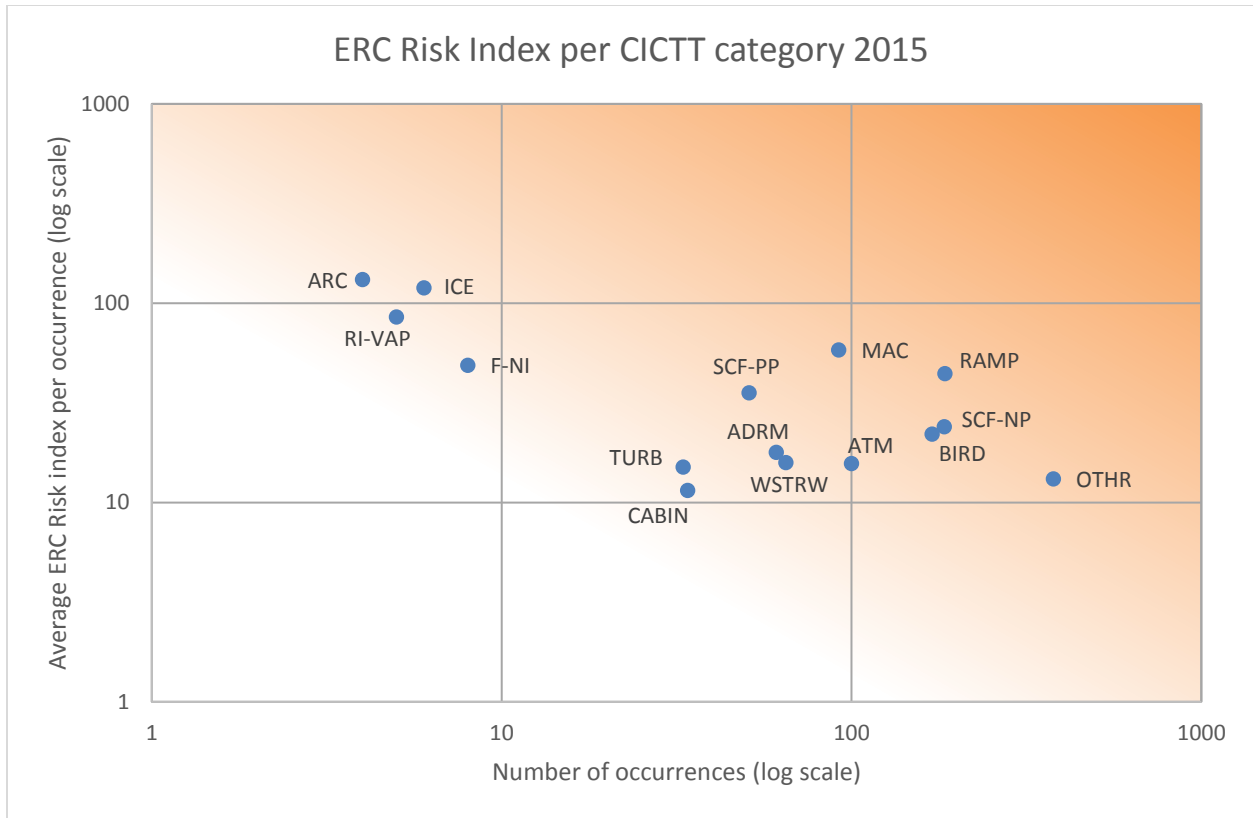


Chart No. 3: Number of occurrences and average risk index per CICTT occurrence category

Description of categories (highest 15 categories, lowest to highest):

- F-NI: Fire or smoke in or on the aircraft, which is not the result of an accident impact
- CABIN: Miscellaneous occurrences in the passenger cabin of transport category aircraft
- RI-VAP: Runway incursion by a vehicle, aircraft or person
- TURB: In-flight turbulence encounter
- ARC: Abnormal runway contact
- ICE: Accumulation of snow, ice, freezing rain, or frost on aircraft surfaces
- WSTRW: Flight into windshear or thunderstorm
- ADRM: Occurrences involving aerodrome design, service, or functionality issues
- ATM: Occurrences involving Air traffic management (ATM) or communications, navigation, or surveillance (CNS) service issues
- SCF-PP: Failure or malfunction of an aircraft system or component - related to the powerplant
- 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
- OTHR: Any occurrence not covered under another category
- MAC: Airprox, ACAS alerts, loss of separation as well as near collisions or collisions between aircraft in flight
- RAMP: Occurrences during (or as a result of) ground handling operations

### 3. Safety issues

#### a. Identification of potential safety issues

Every occurrence reported to DAC is linked to a “potential safety issue”, except for the least severe (ERC Risk index 10 or less) that do not fit with any existing 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.

#### 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:

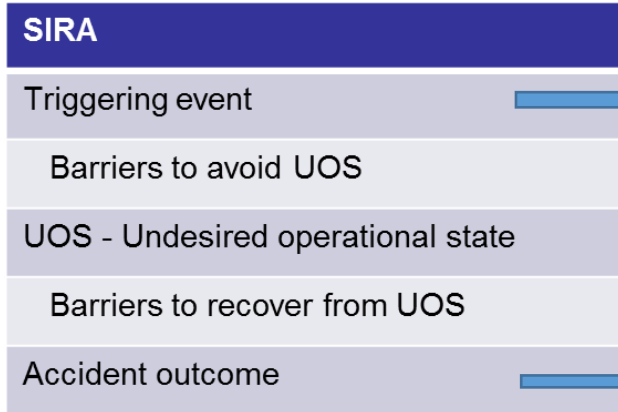
- the triggering event(s)
- the Undesired Operational state UOS
- the potential accident outcome(s)
- the safety barriers to avoid the UOS as well as the safety barriers to recover from the UOS.

In total, 113 potential safety issues are currently being tracked (status August 2016). 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 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





- ATM
- Aerodrome
- Ground handling
- Operational
- Technical



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

TOP 10 SAFETY ISSUES			Potential accident outcomes						
	Safety issue	Accident Severity	CFIT Controlled flight into terrain	LOC-I Loss of control	MAC Mid-air collision	GCOL Collision on ground	RWY-EXC 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	Risk of collision with drone	Catastrophic			X			X	X
4	Mismatch between calculated and actual CG	Catastrophic		X			X		X
5	Engine failure or problems - single engine aircraft <b>GA</b>	Major		X			X	X	
6	Airspace infringement	Catastrophic			X				
7	Icing	Catastrophic		X			X	X	
8	Aircraft not correctly configured for takeoff	Catastrophic		X			X		
9	DGR handling	Catastrophic		X					
10	Technical - pressurisation system	Catastrophic	X	X					

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

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

Compared to 2014, the following issues are new in the Top 10:

- Risk of collision with drone
- Icing: few occurrences but high risk
- Aircraft not correctly configured for takeoff:  
the risk is impacted by 1 serious incident but the overall number increased as well
- Technical - pressurisation system:  
increased number because 2015 is the first full year of monitoring of this safety issue

Significant improvements have been noted for the following issues that were included in the Top 10 of 2014:

- General Aviation: Loss of control during landing
- Hard landing
- Level bust / Altitude bust

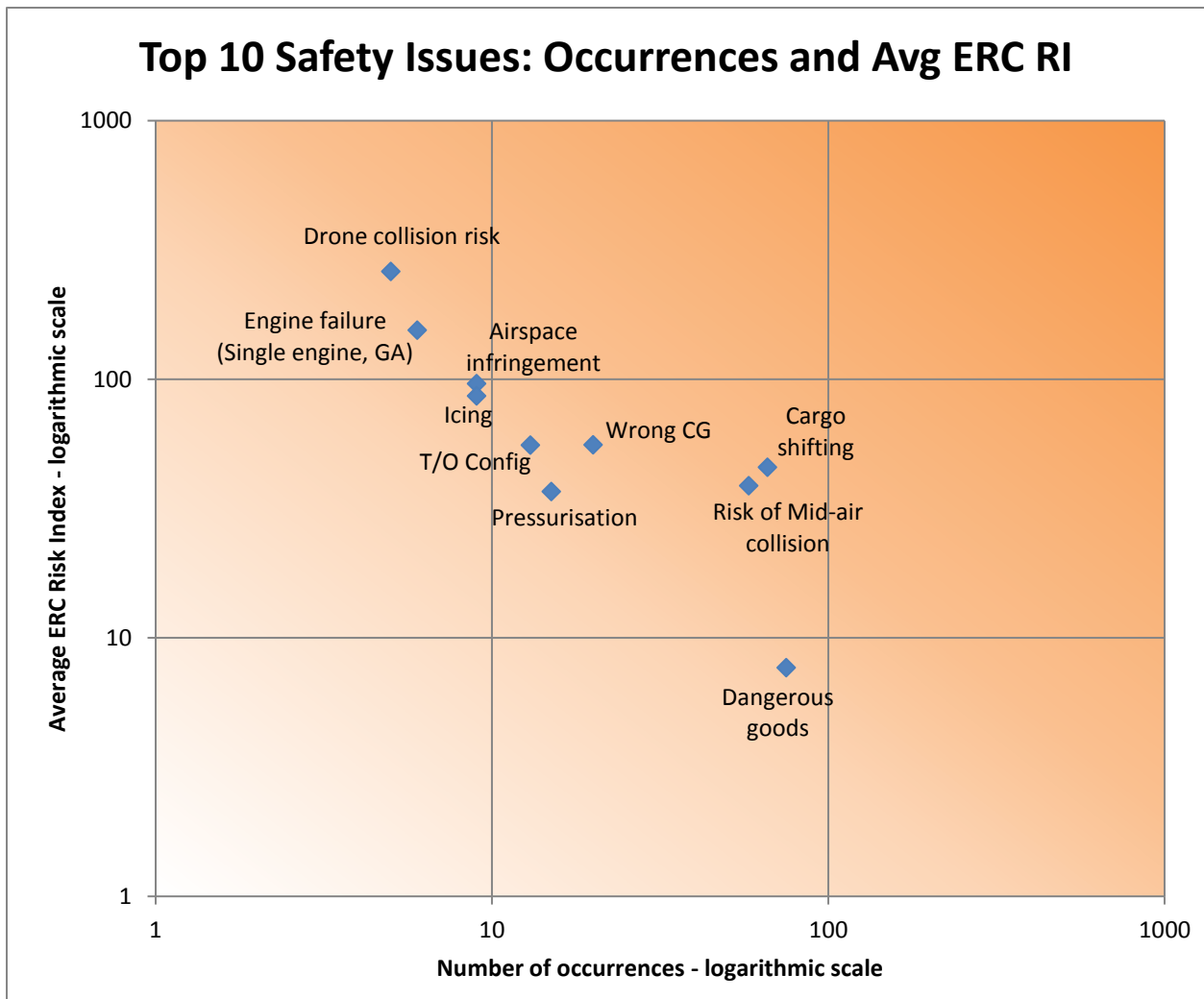


Chart No. 4: Number of occurrences and average risk index linked to the Top Ten safety issues

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 (on logarithmic scales).

As the triggering events for each Safety Issue are linked to one or more aviation domains, the contribution of each domain to the overall risk can be shown.

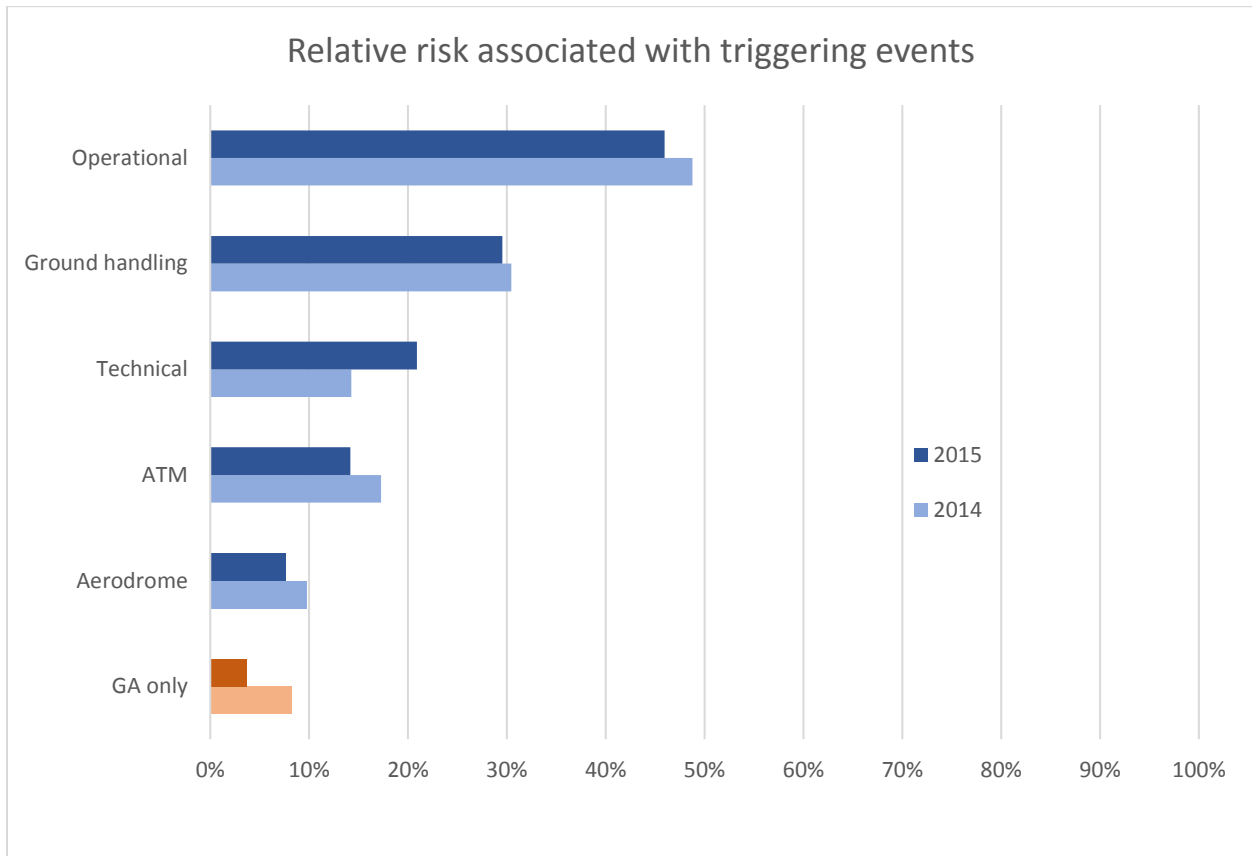


Chart No. 5: Contribution of different aviation domains to the overall risk

Triggering events in the Operations and Ground Handling domains contribute significantly to the total risk. However, by comparison to 2014, only the triggering events of the technical or airworthiness domain have an increased contribution to the overall 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.

Only 4% of the total is related to safety issues specific to general aviation, which is due to the low number of reports.

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						
	SI Title	Accident Severity	CFIT	LOC-I	MAC	Collision on ground	RWY-EXC	Injury or damage in flight	Injury or damage on ground
	Risk of MAC	Catastrophic			X			X	
	Risk of collision with drone	Catastrophic			X			X	X
	Mismatch between calculated and actual CG	Catastrophic		X			X	X	

The important new safety issue is the risk of collision with drones, where several occurrences have been recorded in Luxembourg airspace as well as in other locations. The risk of mid-air collision is linked to a number of different causes, related to both the operations and air traffic management domains.

**c. Ground handling**

TOP 3 GROUND HANDLING SAFETY ISSUES			Accident outcomes						
	SI Title	Accident Severity	CFIT	LOC-I	MAC	Collision on ground	RWY-EXC	Injury or damage in flight	Injury or damage on ground
	Cargo moving/shifting during flight	Catastrophic		X					
	Mismatch between calculated and actual CG	Catastrophic		X			X	X	
	DGR handling	Catastrophic		X				X	X

The Top 3 ground handling safety issues are all related to cargo handling. The highest risk identified is the risk of cargo moving or shifting during flight, which can affect the center of gravity of the aircraft.

Potential differences between the calculated and actual center of gravity can be caused by errors or other issues on both the actual handling of cargo (e.g. loading pallets in the wrong place) and on the operational side (e.g. wrong weight and balance calculation). So the issue “Mismatch between calculated and actual CG” is also tracked as “operational” safety issue, where it also appears in the related Top 3.

d. Airworthiness

TOP 3 AIRWORTHINESS SAFETY ISSUES			Accident outcomes						
SI Title	Accident Severity		CFIT	LOC-I	MAC	Collision on ground	RWY-EXC	Injury or damage in flight	Injury or damage on ground
Engine failure or problems - single engine aircraft <b>GENERAL AVIATION</b>	Major			X			X		X
Technical - pressurisation system	Catastrophic	X	X					X	X
Technical - flight controls	Catastrophic		X				X		X

Technical issues on the pressurization system appear as new issue in the Top 3. No significant link to any specific aircraft type could be established.

e. Air traffic management

TOP 3 ATM-RELATED SAFETY ISSUES			Accident outcomes						
SI Title	Accident Severity		CFIT	LOC-I	MAC	Collision on ground	RWY-EXC	Injury or damage in flight	Injury or damage on ground
Risk of MAC	Catastrophic				X				
Loss of communication	Catastrophic				X	X			
Level bust / Altitude bust	Catastrophic	X			X				

While the number and average risk index of loss of communication events has increased, an improvement has been noted for level bust/altitude bust occurrences.

f. Aerodrome

TOP 3 AERODROME-RELATED SAFETY ISSUES			Accident outcomes						
SI Title	Accident Severity	CFIT	LOC-I	MAC	Collision on ground	RWY-EXC	Injury or damage in flight	Injury or damage on ground	
Runway incursion by a vehicle	Catastrophic				X	X			
Vehicles cutting off aircraft at ELLX entering/exiting apron	Major				X		X		
Runway incursion by a person	Major				X	X			

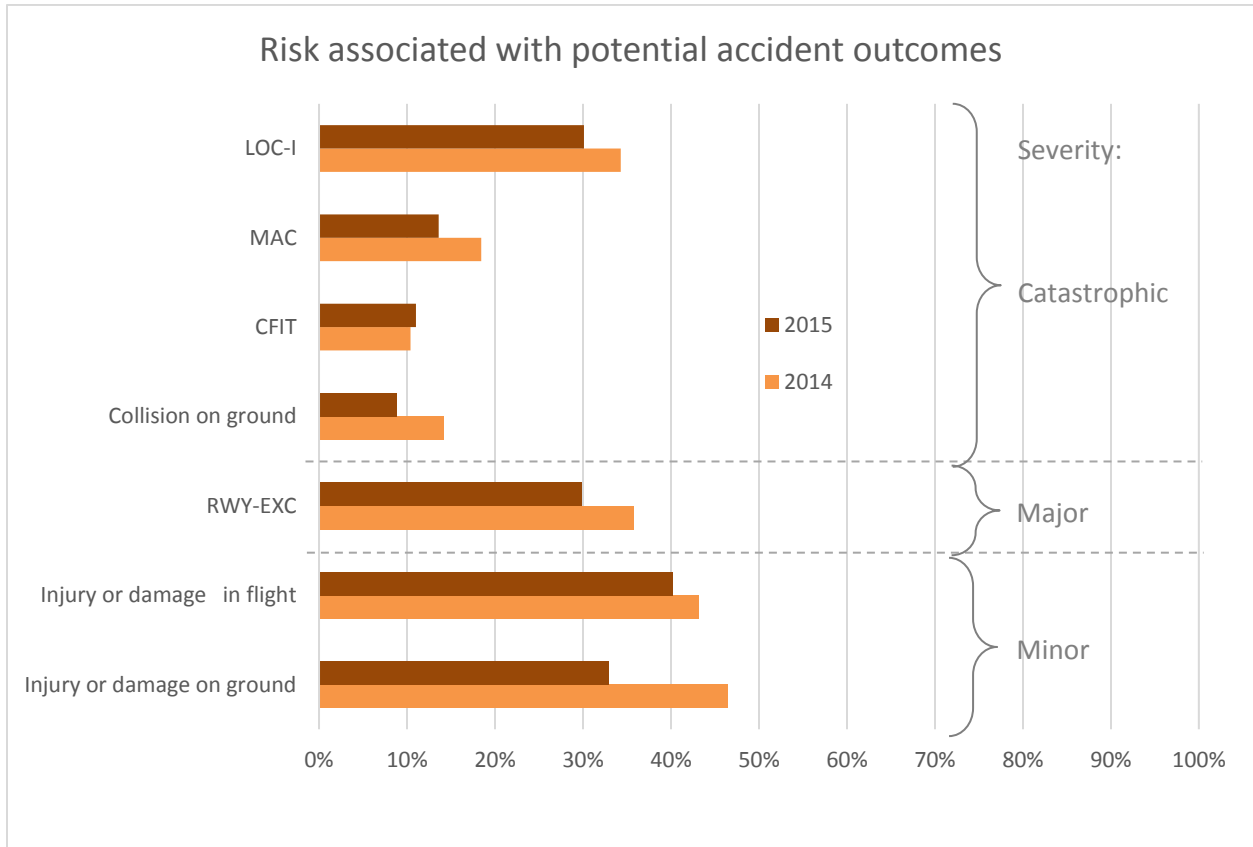
The runway incursions reported in 2015 occurred on airports outside Luxembourg. At Luxembourg airport, the specific layout with the internal road passing between the taxiway and aprons P1-P3 continues to generate incidents with a collision risk between vehicles and taxiing aircraft.

g. General aviation

TOP 3 GENERAL AVIATION SAFETY ISSUES		Accident outcomes						
SI Title	Accident Severity	CFIT	LOC-I	MAC	Collision on ground	RWY-EXC	Injury or damage in flight	Injury or damage on ground
Engine failure or problems - single engine aircraft	Major		X			X		X
Loss of control during landing	Major					X		
Collision with obstacle during taxi	Minor				X			

Only few occurrence reports have been received from General Aviation, other than those that involve a serious incident or accident. Because the overall list is so short, “Loss of control during landing” still appears in second place, but in fact a significant improvement has been noted compared to 2014.

## h. Distribution of risk



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

The highest percentage is still associated with Loss of Control in flight. 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. Conclusions**

The importance of ground handling for aviation safety, already seen in the annual safety report 2014, has been confirmed by the data analysis for 2015. The activities related to loading and securing cargo can have a particularly high safety impact, however they are among the least regulated and supervised of all aviation domains.

A new threat for aviation has emerged in the form of Unmanned aerial vehicles (UAV) or drones. DAC is in the process of defining regulations for both commercial and non-commercial operations of UAV.

## **6. Outlook**

For 2016, a significant increase in the number of occurrence reports is expected due to the full implementation of European Regulation 376/2014. In particular, it is now required from organisations to report their internal voluntary reports to DAC as well.

## 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, windcreens, 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.