International Civil Aviation Organization
Regional Aviation Safety Group - Pan America (RASG-PA)

WORKING PAPER

RASG-PA ESC/27 — WP/04
12/12/16

Twenty-Seventh Regional Aviation Safety Group — Pan America Executive Steering Committee Meeting (RASG-PA ESC/27)
Mexico City, Mexico, 13 to 14 December 2016

Agenda Item 3: **RASG-PA Team Reports**
3.2 Annual Safety Report Team (ASRT)

RASG-PA ANNUAL SAFETY REPORT (ASR)

(Presented by the Secretariat)

EXECUTIVE SUMMARY

This working paper presents to the Twenty-Seventh Regional Aviation Safety Group — Pan America Executive Steering Committee Meeting (RASG-PA ESC/27):

- the results of the review to the Annual Safety Report (ASR), sixth edition;
- the latest decisions of the RASG-PA Executive Steering Committee (ESC) regarding subsequent editions of the report;
- the distribution of the ASR sixth edition; and
- the work plan for the production of the ASR seventh edition.

Action:	Stated in paragraph 3.1 of this working paper
Strategic Objectives:	• Safety
References:	• RASG-PA/02 Meeting Report • RASG-PA Annual Safety Report • RASG-PA/04 Meeting Report • RASG-PA/ESC/16 Meeting Report • ICAO Global Aviation Safety Plan (GASP) • ISSG Global Aviation Safety Roadmap (GASR)

1. Introduction

1.1 The last edition of the ICAO Global Aviation Safety Plan (GASP) contains the following 4 safety areas that need improvement:

- standardization
- collaboration
- investment
- information sharing

1.2 These 4 areas should be addressed first with a safety oversight approach during an estimated implementation period until 2017, when States should have developed effective safety oversight systems to reach 60% compliance in ICAO safety audits, with the industry and the States exchanging safety information. The Bogota and the Port-of-Spain Declarations both pursue the goal of achieving 80% average compliance in the SAM and CAR Regions.

1.3 Between 2017 and 2022, all States should have implemented their SSP, and the RASGs should have incorporated safety management programmes.

1.4 Between 2022 and 2027, States should reach the necessary level to be able to work with predictive safety management system models.

1.5 This vision has been the basis for the work of RASG-PA since its creation, through the adoption of a proactive and/or predictive approach to risk assessment with a view to formulating safety strategies based on the safety information gathered and analysed.

1.6 Since its very beginnings, RASG-PA concluded that an annual safety report (ASR) should be developed in a context of **collaboration** and safety **information sharing**.

1.7 This report would contain 3 sections as follows:

- reactive;
- proactive; and
- predictive

1.8 The consecutive versions of the annual safety report reflect the transition from mainly reactive information to a balance among the three sections, which shows the maturity of the Pan American Region with respect to the capture, exchange, and analysis of safety data. The safety intelligence contained in the seventh edition of the report makes it possible to identify, focus on, and prioritize areas of interest for regional safety, in order to expedite the development and implementation of mitigation measures.

1.9 It is expected that the methodology used in the annual report for analysing reactive, proactive and predictive information, being consistent with Annex 19 to the Convention on International Civil Aviation, will be replicated by State Safety Programmes (SSP) to expedite the identification of trends, support decision-making, and measure the level of maturity attained by each management system.

2. Methodology for the development of the ASR, based on a collaborative exchange of information

2.1 The drafting of the RASG-PA Safety Annual Report requires an active participation by team members, leading to a joint analysis of safety data provided by the different sources of information, using for the assessment the metrics specifically developed for this purpose. Likewise, this will permit the establishment of a shared vision for the identification of the main areas of interest, classifying them by their origin into reactive, proactive or predictive.

2.2 From 6 to 17 June 2016, the team in charge of developing the ASR met at the ICAO South American Regional Office in Lima to work on the drafting of the ASR seventh edition. Currently, the seventh edition is in the drafting phase, awaiting for the completion of mortality risk and accidents registered by Boeing for North America, and IATA data on TEM analysis by accident category, IOSA results and FDX data, estimating the final version will be available during the second quarter of 2017.

2.3 For the drafting of the seventh edition of the ASR, data provided by ICAO, Boeing, IATA, CARSAMMA, and the SRVSOP was used for the different sections of the report. The maturity of the safety data capture and analysis systems in the Pan American Regional considers new challenges, consistent with the information validation mechanisms optimization, in order to manage adequately safety data.

2.4 The seventh edition of the ASR shows that the main safety categories of interest in the Region are still Loss of control in flight (LOC-I), Runway excursions (RE), Controlled flight into terrain (CFIT), and Near miss collision/mid-air collision (MAC), showing a decreasing trend during the analysed periods, in accordance with the respective sources of reactive, proactive and predictive information used in each case.

2.5 Specifically, the reactive section contains valuable information on accident statistics for the period 2006-2015, showing the importance of LOC-I, CFIT and RE as the three main categories in the Region, and MAC as an emerging category, based on the mortality risk analysis.

2.6 Regarding the section on proactive information, the assessment of compliance by States of ICAO standards and procedures based on the USOAP Programme shows that the average effective implementation increased from 65.2% in 2010 to 71.8% in November 2016, and that 10 States in the Pan American Region maintain an effective implementation (EI) of ICAO SARPs below 60%. The EI associated to the qualification and training of technical personnel continues to be the critical element with the lowest level of compliance, together with air navigation services surveillance (ANS) and ground aerodromes (AGA).

2.7 One of the latent conditions identified in 2015 accidents registered by IATA is related to regulatory aspects. Though no direct relation was observed with USOAP most common findings, it would be interesting to conduct a specific study to improve safety decision making

2.8 SRVSOP IDISR programme noticed that most common findings regarding platform inspections were maintenance activities. It appears to be interesting to explore possible correlation with latent conditions identified by IATA, regarding SOPs and verifications during maintenance operations, especially in CAR and SAM regions.

2.9 In the other hand, the section on predictive information showed that precursors of RE, CFIT and MAC categories presented a decreasing trend during the assessed period, while the events related with bank angle and stall warning and manoeuvring being presently evaluated as LOC-I precursors showed a plane trend during the same period.

2.10 In accordance with ICAO Annex 13, near miss collisions requiring an avoidance manoeuvre are considered serious incidents. However, comparing TCAS RA predictive data with States reporting following Annex 13, significant differences were observed. Therefore, it would be interesting to determine if such differences are related to States investigation and reporting policies and if they are eventually correlated to USOAP critical elements in the OPS and AIG areas.

2.8 Finally, the report provides precise guidelines and an evolution structure to better represent the safety reality in the Region. Thus, the ASR team continues trying permanently to optimise the interaction among the different sources of reactive, proactive and predictive information, and the "safety intelligence" concept with a view to better supporting safety-related decisions.

3. Suggested action

3.1 The RASG-PA ESC/27 is invited to:

a) take note of the information provided in this working paper; and

b) take note of the seventh edition of the RASG-PA ASR;

c) request Boeing and IATA to send their contributions to the ASRT as soon as possible in order to speed up the drafting of the seventh edition of the RASG-PA Safety Annual Report.

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ANNUAL SAFETY REPORT

Seventh Edition

INFORME ANUAL DE SEGURIDAD OPERACIONAL – Séptima Edición

Regional Aviation Safety Group – Pan America (RASG-PA)

Grupo Regional de Seguridad Operacional de la Aviación – Pan América (RASG-PA)

Information mainly produced with data from 2006 until 2016

Información producida con datos desde 2006 hasta 2016

Issued in XXXX 2017

Publicado en XXXX de 2017

REGIONAL AVIATION SAFETY GROUP
PAN AMERICA

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Foreword

The Regional Aviation Safety Group – Pan America (RASG-PA) was established in November 2008 as the focal point to ensure harmonization and coordination of efforts aimed at reducing aviation safety risks in the Pan American Region, with the objective to address global aviation safety matters from a regional perspective.

RASG-PA membership includes representatives from all States/Territories of ICAO NAM/CAR and SAM Regions, ICAO, international organizations and industry.

The RASG-PA safety management process, as depicted in Figure 1, consists of four recurrent stages. The process begins with the safety data gathering and analysis to produce safety intelligence, which allows to determine a consolidated vision of the main areas of interest for the development of safety improvement actions tailored to the reality of the Pan American Region.

Figure 1. RASG-PA Safety Management Process

Previous editions of the Annual Safety Report and other RASG-PA related documentation can be downloaded at: www.icao.int/rasgpa. For additional information contact: rasg-pa@icao.int

Introduction

The foremost objective of this report is to identify the main aviation safety areas of interest in the Pan American Region, based on the analysis of specific metrics with an integrated vision from different stakeholders, **becoming a tool for safety intelligence**.

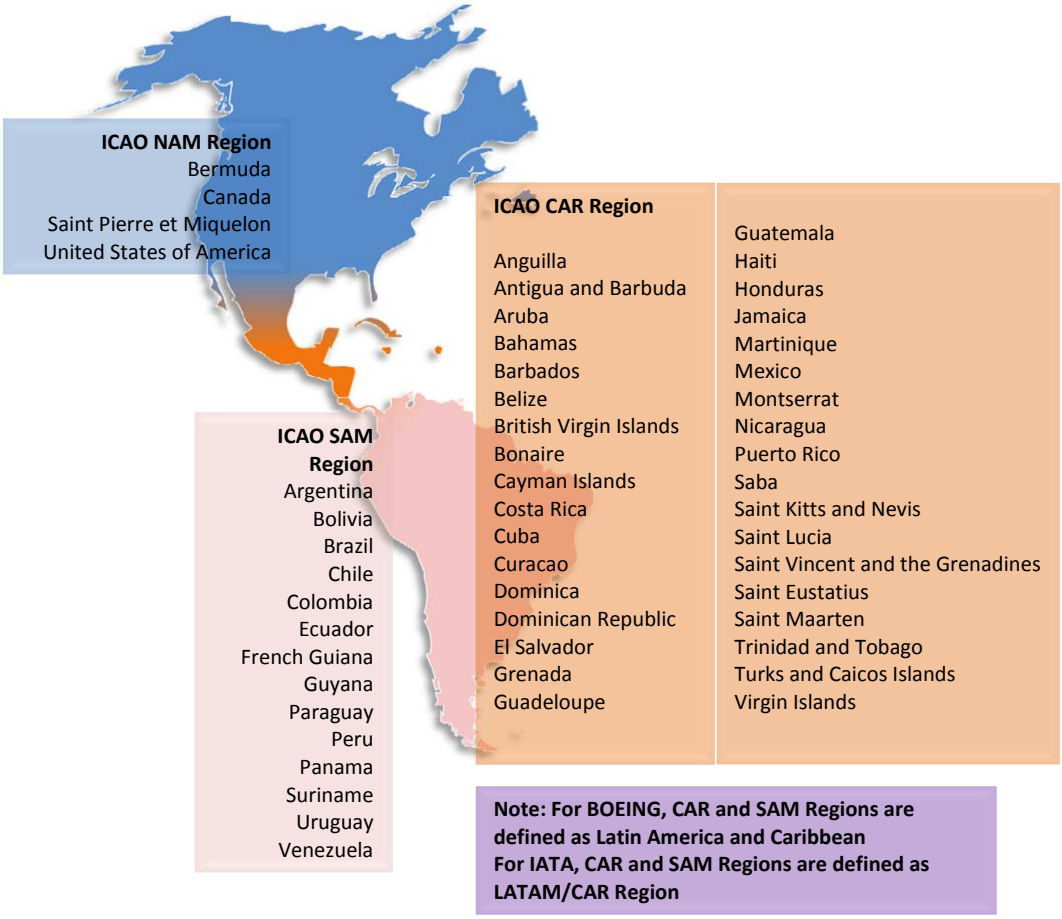
The **first part** of the report is intended to present **safety information** mainly from the latest 10-year period according to the safety management principles. Thus, is divided in three sections:

1. **Reactive** Information: presents safety analysis based upon past occurrences (accidents and incidents) in the Pan American Region.
2. **Proactive** Information: includes analysis of States' existing conditions (ICAO Standards and Recommended Practices implementation, traffic) and service providers (IATA Operational Safety Audits).
3. **Predictive** Information: based upon analysis of Flight Operations Quality Assurance (FOQA) de-identified data, oriented towards identifying future hazards for initiating corresponding risk mitigation actions.

In every version of this report is also reflected the improvement of the Region in processing and exchanging reactive, proactive and predictive information, by transitioning from almost only reactive information, to a balance on the contents of each section.

The **second part** of the report presents **safety intelligence** as the result of the safety information analysis, and establishes correlations of interest for facilitating the decision making process and for the benefit of aviation safety.

Figure 2. The Pan American Region (RASG-PA Region)



Executive Summary

The results of the analysis of regional aviation safety data showed that the top categories to focus safety enhancement initiatives are related to:

- Loss of Control In-flight (LOC-I)
- Runway Excursion (RE)
- Controlled Flight Into Terrain (CFIT)
- Mid-Air Collision (MAC)

According to the statistics in this report, the number of fatal accidents in 2015 in the Pan American Region for scheduled commercial air transport operations involving aircraft with maximum take-off mass (MTOM) above 5,700 kilograms remained below both world average and regional latest 10-year moving average.

The four accident categories of interest (LOC-I, RE, CFIT and MAC) continued to show decreasing trends through the latest ten-year period, not only while looking at the reactive data, but also according to the behaviour of their precursors, as described in the predictive safety information section of this report.

The analysis conducted to determine correlations between critical elements and areas of the ICAO Universal Safety Oversight Audit Programme (USOAP), showed that main findings for NAM and SAM Regions were related to CE 4 (Qualification and Training of Technical Staff) and Air Navigation Systems (ANS). For CAR Region, main findings involved CE 6 (Licensing and Certification Obligations) with regard to Aerodrome and Ground Aids (AGA).

Taking in account the projected commercial traffic growth for CAR and SAM Regions, proactive analysis also reinforces the necessity to improve Air Navigation Services (ANS), Aerodromes and Ground Aids (AGA) and Accident and Incident Investigation (AIG) areas in the CAR and SAM Regions.

IOSA results...

Another correlations according to data update.

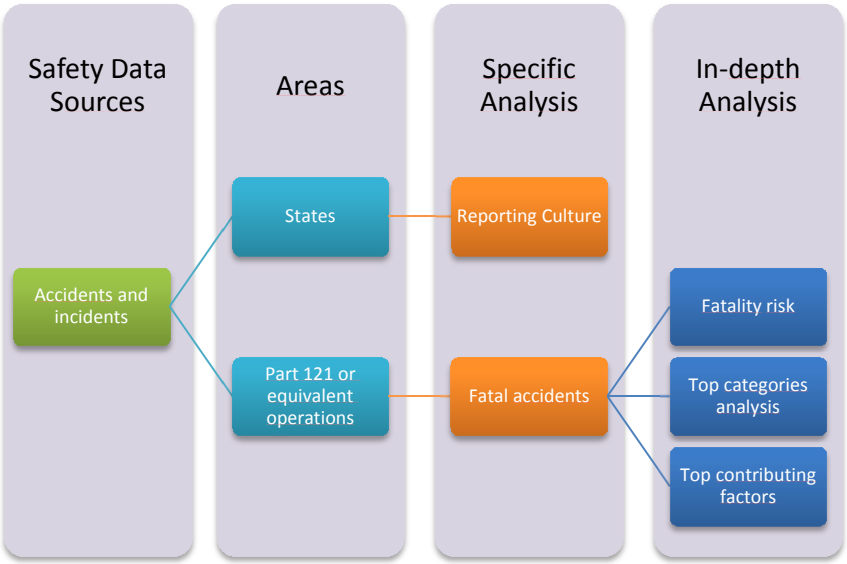
First Part: Safety Information

1 Reactive Safety Information

This section will assist with comprehending the behaviour of the Pan American Region with regard to Safety, based upon the analysis of reactive safety data (accidents and incidents).

The process followed by the RASG-PA Annual Safety Report Team (ASRT) for analysing reactive information consists of retrieving safety data from Boeing, IATA and ICAO, and using an approach **from a general perspective to specific areas**, highlighting the safety concerns at different levels, which is depicted in Figure 3.

Figure 3. Reactive Safety Data Analysis



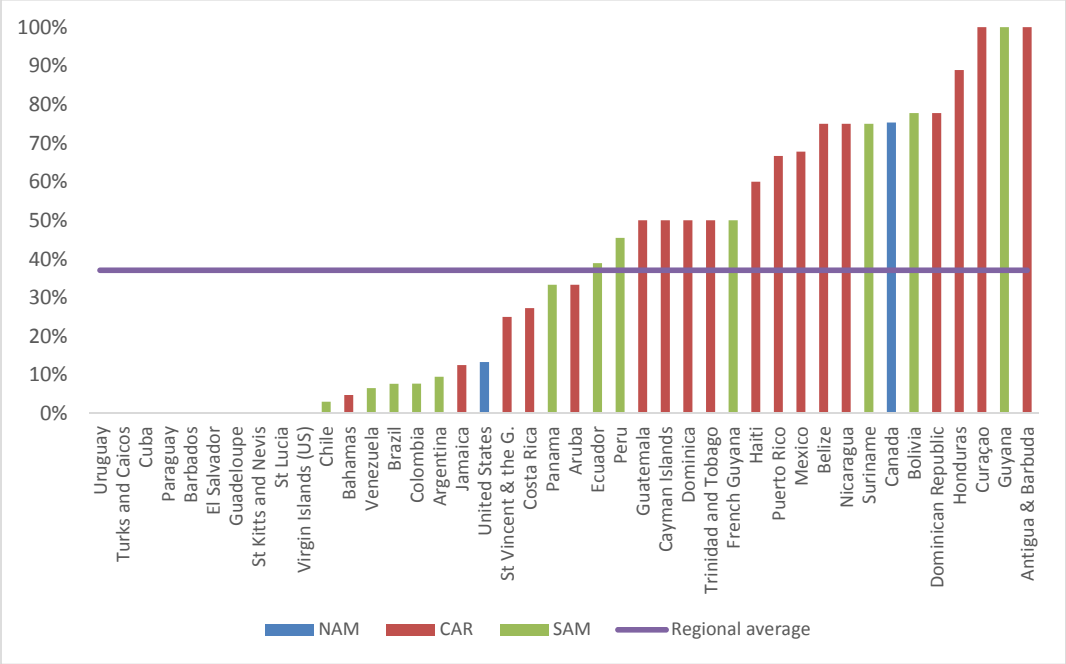
At the time of analysis, there were 4031 occurrences[1] reports (accidents, serious incidents and incidents) belonging to the Pan American Region recorded in the ICAO ADREP/ECCAIRS database[2] for the period 2005-2014, distributed as follows: 2596 for the NAM Region, 406 for the CAR Region and 1029 for the SAM Region.

In order to obtain a metric for the **reporting culture in the Pan American Region based on compliance with Annex 13 to the Convention on International Civil Aviation**, the ICAO ADREP/ECCAIRS database was queried to retrieve **official reports** (based on data provided by the States in compliance with Annex 13) and **unofficial reports** (occurrences not reported to ICAO by the competent authority, but where there is sufficient information to code them). Figure 4 illustrates the percentage of unofficial reports per State, irrespective of the number of occurrences.

Figure 4. Percentage of unofficial Reports per State by ICAO Region, 2006-2015 (ICAO ADREP/ECCAIRS)

UPDATED 14.JUN.2016

[1] Occurrence: An event leading to undesired/unexpected consequences. ADREP/ECCAIRS Taxonomy classifies occurrences in relation to severity (accident, serious incident, etc.) and their categories (runway excursion, loss of control in-flight, etc.)
[2] The ICAO ADREP/ECCAIRS data used in this report was consulted on March 30, 2016.



Analysis of the data shows that the regional average of unofficial reports for the period 2006 – 2015 was 37,1%. 22 States of the Pan American Region remained below the regional average.

1.1 Fatal Accidents during Commercial Air Transport Operations

According to the ICAO ADREP/ECCAIRS and iSTARS accidents (as defined by the Annex 13 to the Convention on International Civil Aviation) in the Pan American Region involving aircraft with Maximum Take-off Mass (MTOM) **above 5,700 kilograms during scheduled commercial air transport operations**, during the time period between 2006 and 2015 reached 401 in total. 8% of those accidents resulted in fatalities.

The distribution of 2015 global accidents, fatal accidents and fatalities by RASG (Regional Aviation Safety Group) is shown in table 1. Also, table 2 shows the specific numbers for the Pan American Region.

Table 1. Accident Statistics and Accident Rates - 2015 (ICAO iSTARS)

UPDATED 13. JUN.2016

RASG	Estimated Departures (in millions)	Number of accidents	Accident rate (per million departures)	Fatalities	Share of Traffic	Share of Accidents
AFI	4.4	6	7.31	0	14%	6%
APAC	6.3	24	2.61	98	21%	24%
EUR	10.7	35	3.05	150	35%	35%
MID	0.7	3	2.46	224	2%	3%
PA	8.5	33	2.58	2	28%	33%
WORLD	30.6	101	2.79	474	100%	100%
Scheduled Commercial Air Transport (Aircraft MTOM above 5,700 kilograms)						

Table 2. Pan America Scheduled Commercial Air Transport Accidents (ICAO ADREP/ECCAIRS and iSTARS)

UPDATED 13.JUN.2016

PAN AMERICA Scheduled Commercial Air Transport[3] Accidents[4]			
Year	**Total Accidents**	**Fatal accidents[5]**	**Total fatalities**
2006-2015 avg.	40.1	3.2	75.5
2014	41	0	0
2015	33	1	2
This table refers to Scheduled Commercial Air Transport Accidents – Aircraft MTOM above 5,700 kilograms			

It is important to note that the number of accidents in 2015 was lower than previous years. Fatal accidents and total fatalities (which achieved their lowest values in 2014) also remained below the previous 10-year average.

1.1.1 Main Findings

1.1.1.1 Contributing Factors to 2011-2015 Accidents in NAM and LATAM/CAR Regions (IATA)

This section presents the analysis of the **2011-2015 IATA recorded accidents[6]** for the Pan American Region, using a classification system based on the Threat and Error Management (TEM) framework.

Table 3. Top Contributing Factors[7] for NAM Region Accidents, 2011-2015 (IATA)

UPDATED 10.JUN.2016

Latent conditions	15% Regulatory oversight 10% Technology and equipment 8% Maintenance Ops: SOPs and checking	
Threats	**Environmental**	28% Meteorology 18% Wind/wind shear/gusty wind 13% Airport facilities
	Airline	27% Aircraft malfunction 15% Gear / tire 8% Maintenance events
Flight Crew Errors	17% Manual handling / flight controls 12% SOP adherence / SOP cross-verification Failure to go around after unstable approach	
Undesired Aircraft States	13% Long / floated / bounced / firm / off-center /crabbed landing 13% Vertical / lateral / speed deviation 5% Controlled flight towards terrain	
Countermeasures	10% Overall crew performance 10% Monitor / Cross-check 3% Contingency management	

3 An air service open-to-use by the general public and operated according to a published timetable or with such a regular frequency that it constitutes an easily recognizable systematic series of flights, which are open to direct booking by members of the public, according to ICAO DOC 9626.

4 ICAO ADREP/ECCAIRS provided data from 2006 to 2007. Data from 2008 to 2015 was retrieved from ICAO iSTARS.

5 An accident where at least one passenger or crewmember is killed or later dies (within 30 days following the accident date).

6 Includes fixed-wing aircraft over 5,700 kg with jet or turboprop propulsion engaged in commercial operations. The accident definition is based on the ICAO Annex 13, and includes a metric for the severity of the damage. Injury only accidents are not included in the analysis.

7 Latent Conditions: conditions present in the system before the accident and triggered by various possible factors.
Threats: an event or error that occurs outside the influence of the flight crew, but which requires crew attention and management if safety margins are to be maintained.
Flight Crew Errors: an observed flight crew deviation from organizational expectations or crew intentions.
Undesired Aircraft States: a flight crew induced aircraft state that clearly reduces safety margins; a safety-compromising situation that results from ineffective error management. An undesired aircraft state is recoverable.

Table 4. Top Contributing Factors for LATAM/CAR Region Accidents, 2011-2015 (IATA)

UPDATED JUN.10.2016

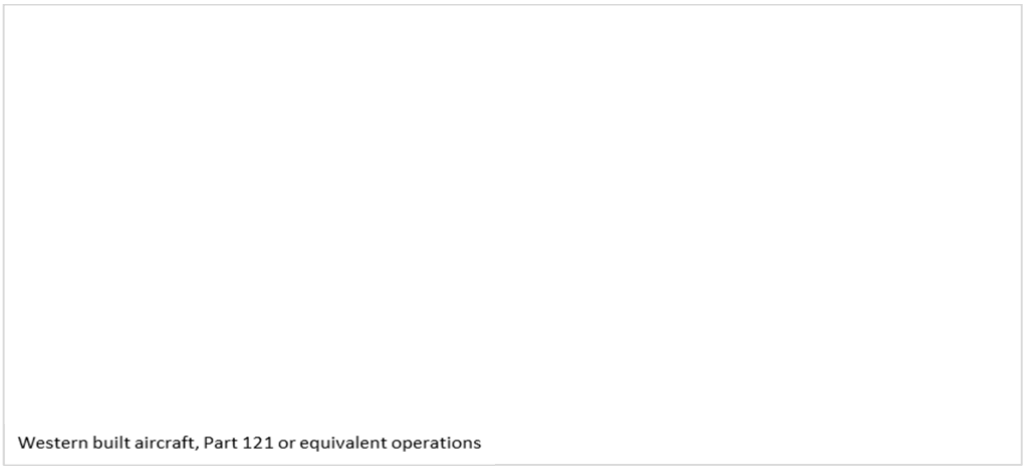
Latent conditions	26% Regulatory oversight 23% Safety management 19% Maintenance operations: SOPs and checking	
Threats	**Environmental**	16% Nav Aids 16% Ground-based nav aid malfunction or not available 13% Meteorology
	Airline	45% Aircraft malfunction 29% Gear/Tire 19% Maintenance events
Flight Crew Errors	13% Manual handling/flight controls 6% SOP adherence/SOP cross-verification 6% Pilot-to-pilot communication	
Undesired Aircraft States	16% Long/floated/bounced/firm/off-center/crabbed land 13% Vertical/lateral/speed deviation 10% Continued landing after unstable approach	
Countermeasures	19% Overall crew performance 16% Monitor/cross-check 10% Communication environment	

1.1.1.2 Most Frequent Accident Categories

Data from 2006 to 2015 analyzed by Boeing consisted in accidents resulting in hull losses and/or onboard fatalities involving western built aircraft during part 121 or equivalent operations (greater than 9 seats or greater than 7,500 pounds of cargo capacity), classified by the State of Operator, and revealed CFIT, LOC-I and RE (Takeoff and Landing) as the top categories of interest in **North America**. The results of this analysis are depicted in Figure 5.

Figure 5. North America portion of fatality risk by accident type, 2006-2015 (Boeing)

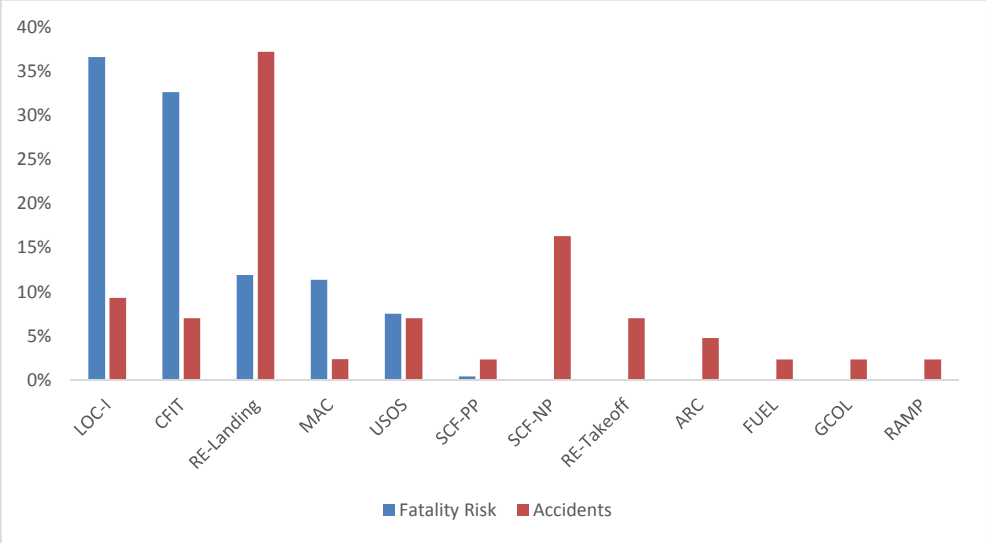
PENDING FOR UPDATE. NAM DATA REQUIRED



In **Latin America and the Caribbean**, Boeing determined LOC-I, RE, CFIT and MAC as the top fatality risk categories, as presented in the Figure 6.

Figure 6. Latin America & Caribbean portion of fatality risk by accident category. 2006-2015 (Boeing)

UPDATED 14.JUN.2016



1.1.1.3 In-depth Analysis of Runway Excursion Data

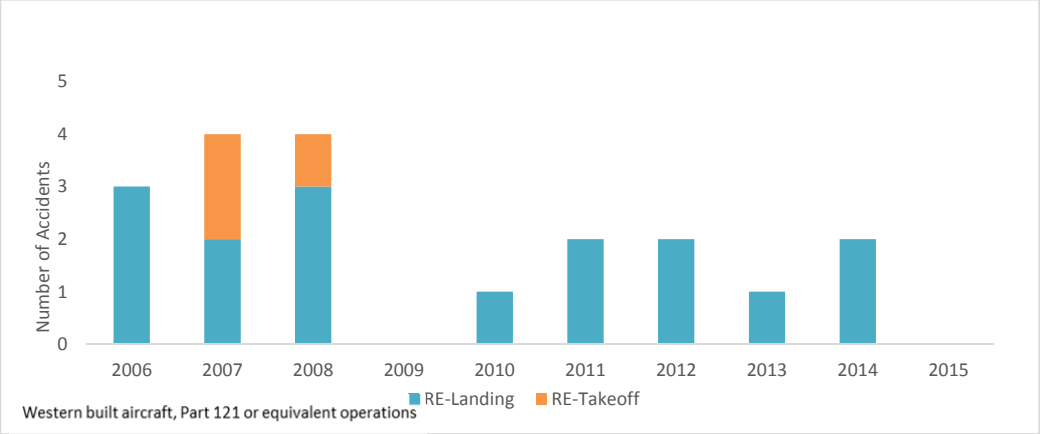
According to Boeing, the distribution of this type of occurrence from 2006 to 2015, divided by **operator domicile** in the Pan American Region, showed the following trends:

Figure 7. Runway Excursion: Operator Domicile: North America, 2006-2015 (Boeing)

PENDING FOR UPDATE. NAM DATA REQUIRED

Figure 8. Runway Excursion: Operator Domicile: Latin America & Caribbean, 2006-2015 (Boeing)

UPDATED 14.JUN.2016



IATA determined the Top Contributing Factors regarding runway excursion accidents occurred worldwide as shown in the following table.

Table 5. Top Contributing Factors for Global Runway Excursion Accidents, 2010-2014 (IATA)

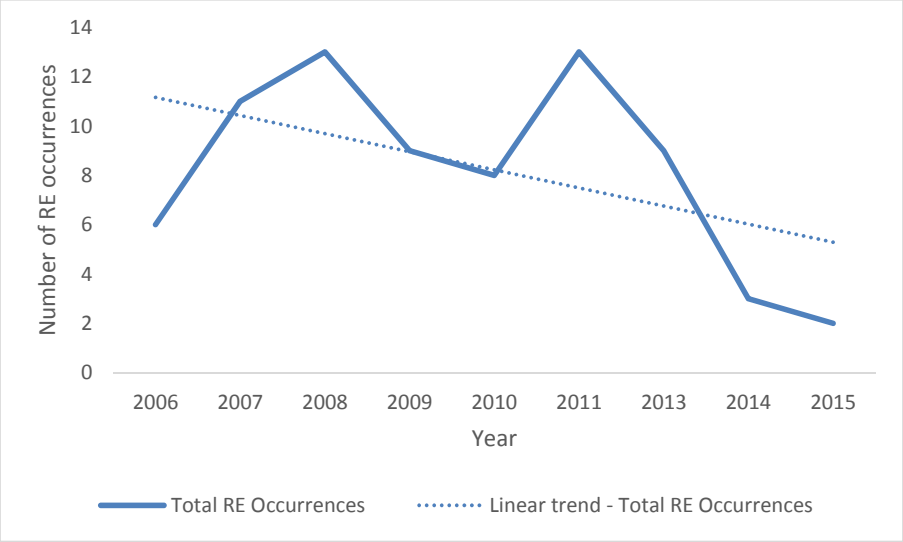
PENDING FOR UPDATE. IATA GLOBAL DATA REQUIRED

Latent conditions		
Threats	**Environmental**	
	Airline	
Flight Crew Errors		
Undesired Aircraft States		
Countermeasures		
Additional Classifications		

ICAO data shows that despite the number of fatal accidents categorized as RE occurred during the time period, total regional occurrence data, including all records of accidents and incident involving aircraft with MTOM above 5,700 kilograms during scheduled commercial air transport operations, showed 74 runway excursions (an average of 7.4 per year) in the last 10-year moving period (2006-2015) with a decreasing trend. The most frequent categories associated to RE were Abnormal Runway Contact (ARC) (15% of REs), Loss of Control – Ground (LOC-G) (14% of REs) and System/Component Failure or Malfunction non-powerplant (SCF-NP) (9% of REs), all of them showing decreasing trends. The number of REs per year are depicted in the following figure.

Figure 9. RE Total Occurrences Distribution per Year – Pan America

UPDATED 16.JUN.2016



1.1.1.4 In-depth Analysis of Controlled Flight Into Terrain Data

According to Boeing, CFIT accidents since 1987 in the Pan American Region by operator domicile show the variations as depicted in Figure 10.

Figure 10. CFIT Accidents per Operator Domicile, 2005-2014

PENDING FOR UPDATE. DATA FROM NAM REQUIRED

In accordance with IATA, the main latent conditions for CFIT Accidents are related to poor regulatory oversight or Technology and equipment. These and other facts are depicted in the following table.

Table 6. Top Contributing Factors for Global CFIT Accidents, 2010-2014 (IATA)

PENDING FOR UPDATE. IATA GLOBAL DATA REQUIRED

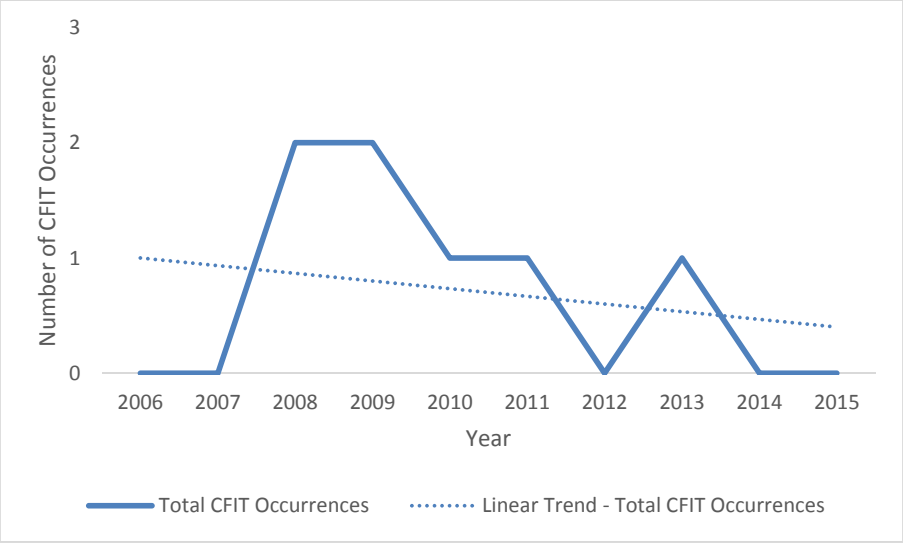
Latent conditions	

Threats	**Environmental**	
	Airline	
Flight Crew Errors		
Undesired Aircraft States		
Countermeasures		
Additional Classifications		

According to ICAO ADREP/ECCAIRS, CFIT showed an average of 0.7 total occurrences (accidents and incidents) in the Pan American Region within the latest 10-year moving average (2006-2015), with a decreasing trend. In 2 cases, USOS (Undershoot/overshoot) category was also identified. The specific numbers of CFIT category per year are presented in the following figure.

Figure 11. CFIT Total Occurrences Distribution per Year – Pan America

UPDATED 16.JUN.2016



1.1.1.5 In-depth Analysis of Loss of Control In-flight Data

Boeing shows the variation of this category in accidents by operator domicile in the Pan American Region in Figure 12.

Figure 12. LOC-I Accidents per Operator Domicile, 2005-2014 (Boeing)

PENDING FOR UPDATE. DATA FROM NAM REQUIRED

IATA Top Contributing Factors for LOC-I Accidents are shown in the following table.

Table 7. Top Contributing Factors for Global LOC-I Accidents, 2010-2014 (IATA)

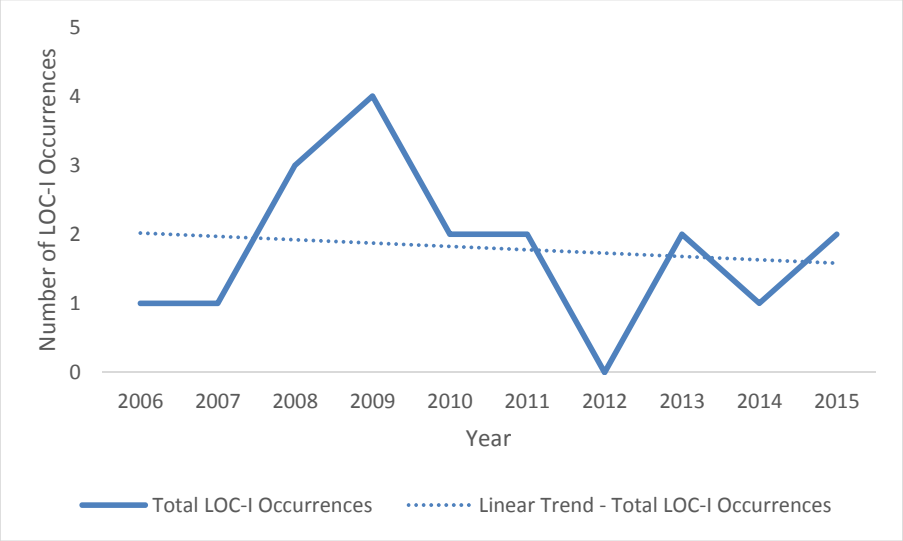
PENDING FOR UPDATE. IATA GLOBAL DATA REQUIRED.

Latent conditions	27% Safety management 21% Flight operations: Training systems 21% Regulatory oversight 15% Flight operations: SOPs and checking 12% Selection systems	
Threats	**Environmental**	42% Meteorology: Icing conditions (36%), poor visibility/IMC (36%), thunderstorms (36%) 12% Lack of visual reference 9% Ground-based nav aid malfunction or not available
	Airline	42% Aircraft malfunction: Contained engine failure/ powerplant malfunction (64%), Fire/smoke (Cockpit/cabin/cargo) (14%) 9% Operational pressure 9% Maintenance events
Flight Crew Errors	33% Manual handling/flight controls 30% SOP adherence/SOP cross-verification: Intentional non-compliance (60%), unintentional non-compliance (40%) 9% Callouts	
Undesired Aircraft States	24% Vertical/lateral speed deviation 18% Operation outside of aircraft limitations 18% Unnecesary weather penetration 12% Unstable approach 6% Abrupt aircraft control	
Countermeasures	36% Overall crew performance 18% Contingency management 12% Captain should show leadership 12% Leadership	
Additional Classifications	13% Insufficient data for contributing factors	

ICAO data shows that LOC-I total occurrences showed an average of 1.8 per year, with a slightly decreasing trend in the period 2006-2015. 22% of these occurrences was associated to powerplant or system failure/malfunction (SCF-PP or SCF-NP categories). Detailed distribution of LOC-I occurrences is shown in the following figure.

Figure 13. LOC-I Total Occurrences Distribution per Year – Pan America (ICAO ADREP/ECCAIRS)

UPDATED 16.JUN.2016

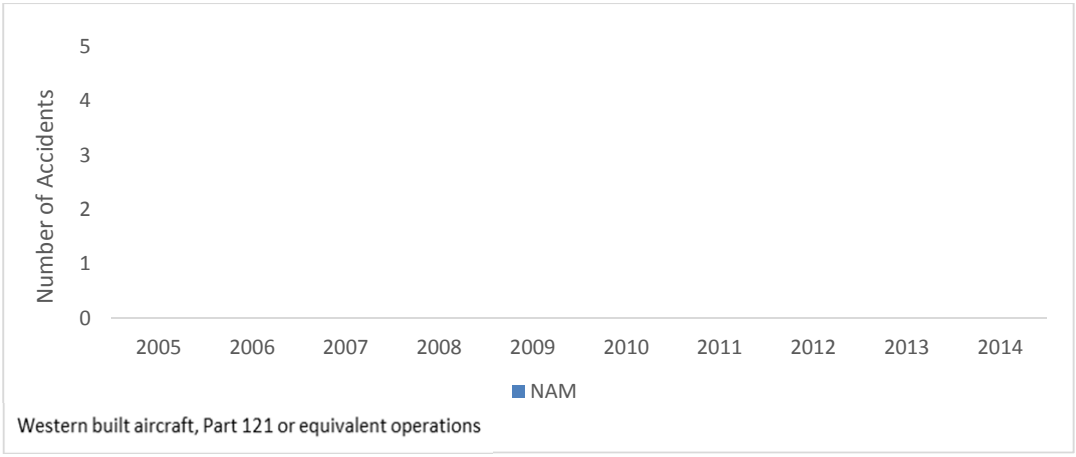


1.1.1.6 In-depth Analysis of Mid Air Collision Data

According to Boeing, MAC categorized accidents varied during the time period from 2005 to 2014 as shown in Figure 14.

Figure 14. MAC Accidents per Operator Domicile, 2005-2014 (Boeing)

PENDING FOR UPDATE. DATA FROM NAM REGION REQUIRED

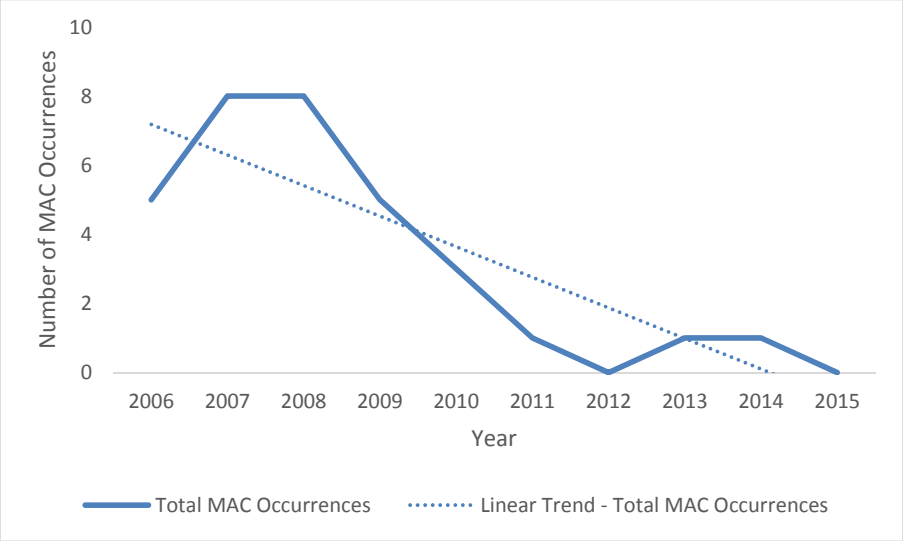


IATA recorded one accident in the latest five year period (2010-2014), but no contributing factors nor relationships of interest were published.

ICAO data shows 32 total MAC occurrences in the time period from 2006 to 2015, in the Pan American Region, with a decreasing trend in the last four years of the period, as presented in the following figure. In 25% of these occurrences, it was found an association to Air Traffic Management category (ATM).

Figure 15. MAC Total Occurrences Distribution per Year – Pan America (ICAO ADREP/ECCAIRS)

UPDATED 16.JUN.2016



1.1.2 IATA Operational Safety Audit (IOSA) Summary

IOSA is a global program built on ICAO standards and industry best practices.

The analysis performed by IATA, comparing the number of recorded accidents per million sectors[8] flown for IOSA registered airlines versus non-IOSA registered airlines, indicates lower rates for IOSA operators in both NAM and LATAM/CAR Regions as shown in the following figures.

Figure 16. NAM Accidents per million sectors flown, 2006-2015 (IATA)

UPDATED 13.JUN.2016

[8] IATA defines "sector" as the operation of an aircraft between takeoff at one location and landing at another location (other than a diversion).

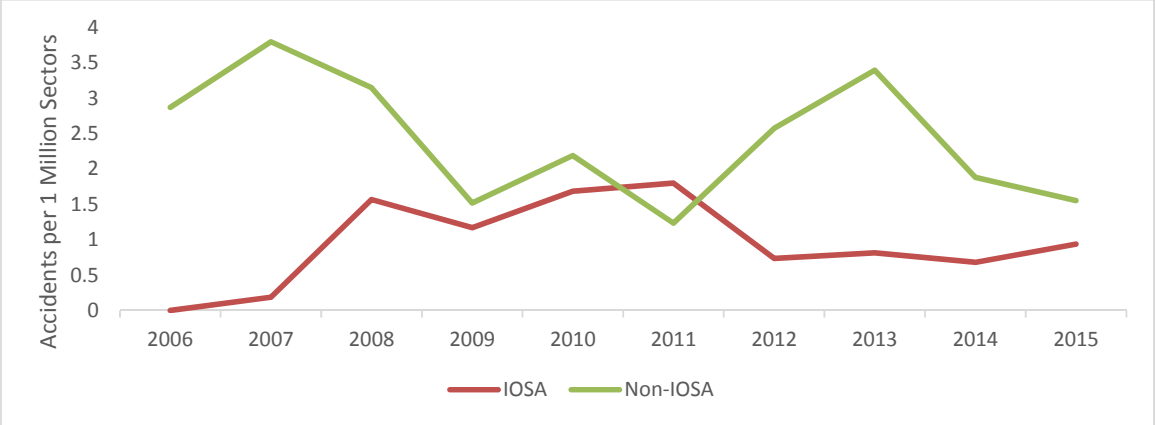
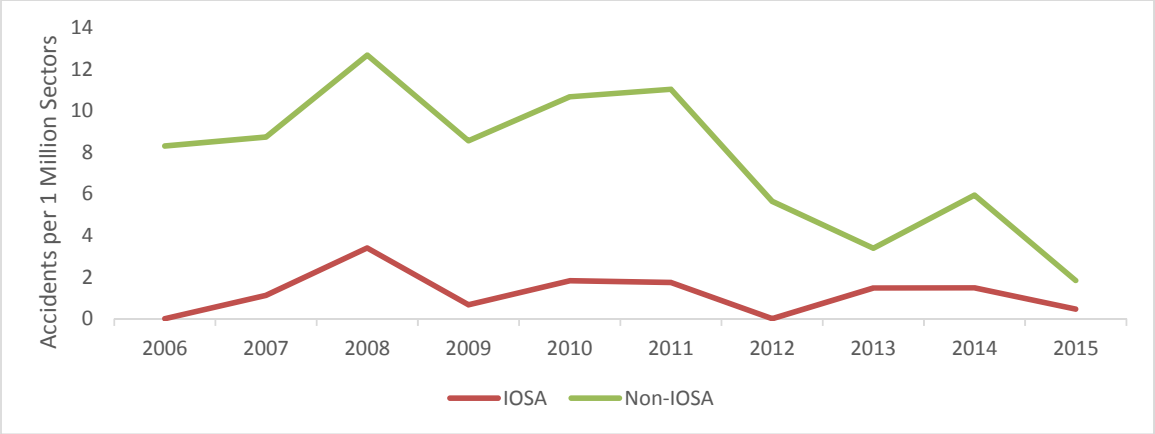


Figure 17. LATAM/CAR Accidents per million sectors flown, 2006-2015 (IATA)

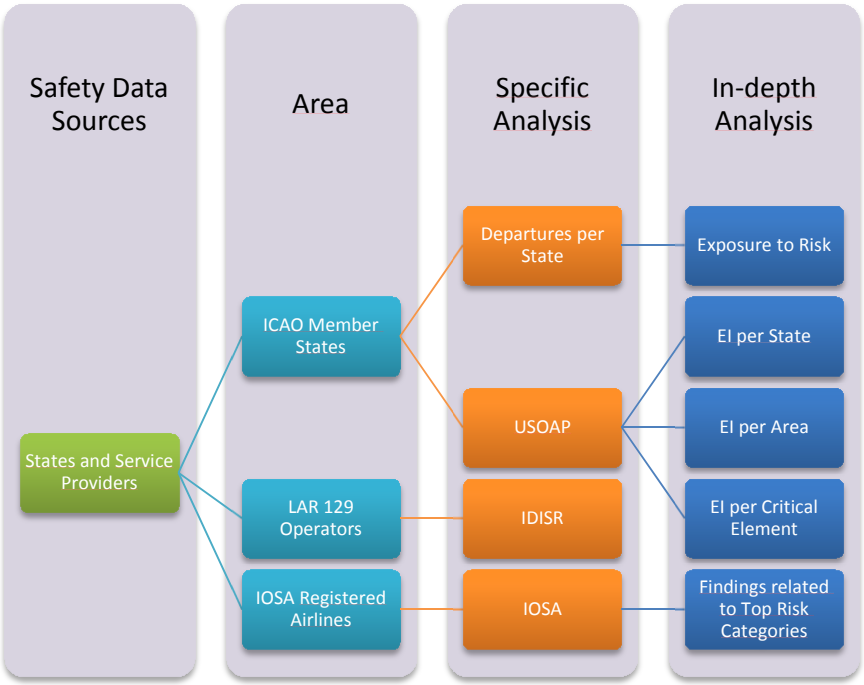
UPDATED 13.JUN.2016



2 Proactive Safety Information

This section contains safety information that can be categorized as proactive, which may show the level of exposure to risks based upon current safety oversight and management processes at State and/or service provider levels. The following figure depicts the extent of the analysis presented in this section.

Figure 18. Proactive Safety Data Analysis



2.1 ICAO Universal Safety Oversight Audit Programme Continuous Monitoring Approach (USOAP CMA)

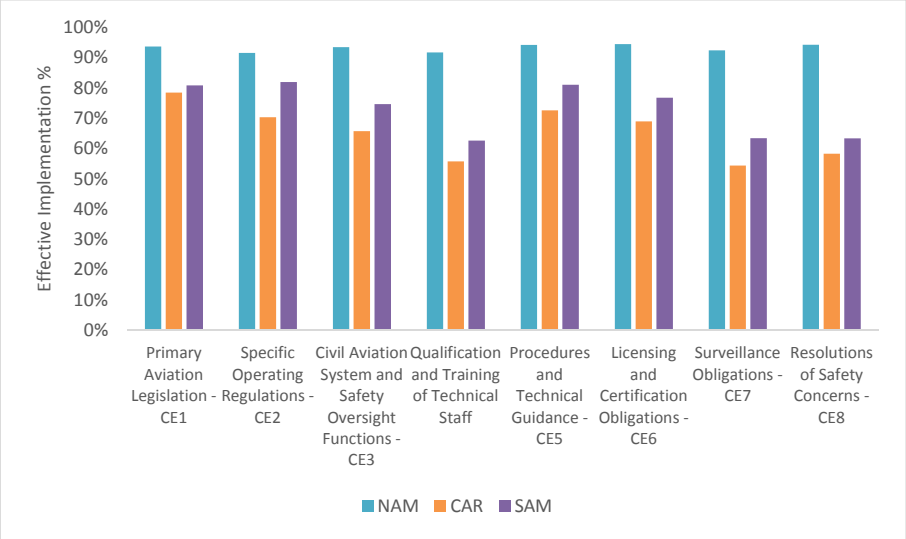
Results of the USOAP are presented to show the Effective Implementation (EI) by States in reference to the 8 Critical Elements (CEs), which ICAO considers essential for a State to establish, maintain and improve in order to have an effective safety oversight system.

According to ICAO iSTARS[9] (Integrated Safety Trend Analysis and Reporting System), **CE4: technical staff qualifications and training** is the top issue affecting the effective implementation percentage in the Pan American Region. This and other facts are shown in Figure 19.

Figure 19. Effective Implementation per CE by Region (ICAO iSTARS)

UPDATED 7.DEC.2016

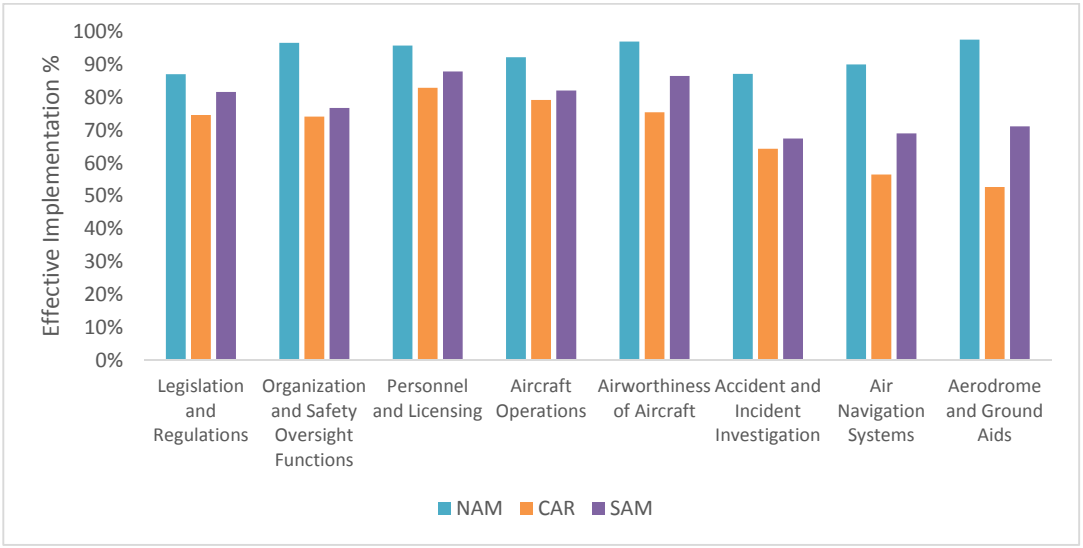
9 iSTARS data as of June 15th 2016.



The results of USOAP/CMA also show the safety oversight systems of the States from a process - perspective in eight technical areas, as presented in the following graph.

Figure 20. Effective Implementation per Area by Region (ICAO iSTARS)

UPDATED 7.DEC.2016



An analysis conducted to determine correlations between critical elements and areas, showed that main findings for Pan America were related to critical element 6 especially with regard to Aerodrome and Ground Aids (AGA) and critical elements 3 and 4 in the Air Navigation Systems (ANS) area.

The following tables show the average values of USOAP findings per critical element per area by Region.

Table 8. NAM Region USOAP average findings per critical element per area

	LEG	ORG	PEL	OPS	AIR	AIG	ANS	AGA

CE1	1			1		1		
CE2	2		2	2	3	1	3	4
CE3		1		1		3	5	
CE4				1	1	2	8	1
CE5				1	3	5	2	
CE6			2	6	2		5	2
CE7			1		3		5	
CE8						3	1	

The most recurrent findings in NAM Region were related to ANS area regarding CE 4 and in OPS area with regard to CE 6.

Table 9. CAR Region USOAP average findings per critical element per area

CE	LEG	ORG	PEL	OPS	AIR	AIG	ANS	AGA
CE1	3	1		1		3	2	1
CE2	3		2	3	8	5	5	9
CE3		3	3	3	2	5	22	3
CE4		2	4	3	4	4	21	4
CE5	1	1	3	5	8	15	5	7
CE6			4	11	6		18	28
CE7			3	4	3		13	12
CE8			2	3	2	6	5	5

In the case of CAR Region, main findings involved CE 6 regarding AGA area and CE 3 and 4 with regard to ANS.

Table 10. SAM Region USOAP average findings per critical element per area

	LEG	ORG	PEL	OPS	AIR	AIG	ANS	AGA
CE1	3	1		1		4	2	1
CE2	3		2	3	4	5	5	6
CE3		4	3	4	2	4	18	3
CE4		1	4	3	3	4	26	3
CE5	1	1	3	5	6	18	3	5
CE6			5	13	7		17	20
CE7			3	4	2		13	10
CE8			4	4	2	5	6	5

In SAM Region, the most common findings detected in USOAP were in the ANS area, especially with regard to CE 4 and AGA in relation to CE 6.

The following figure shows detailed distribution of the percentage of effective implementation by State in the Pan American Region.

Figure 21. Effective implementation per State by Region (ICAO iSTARS)

UPDATED 7.DEC.2016

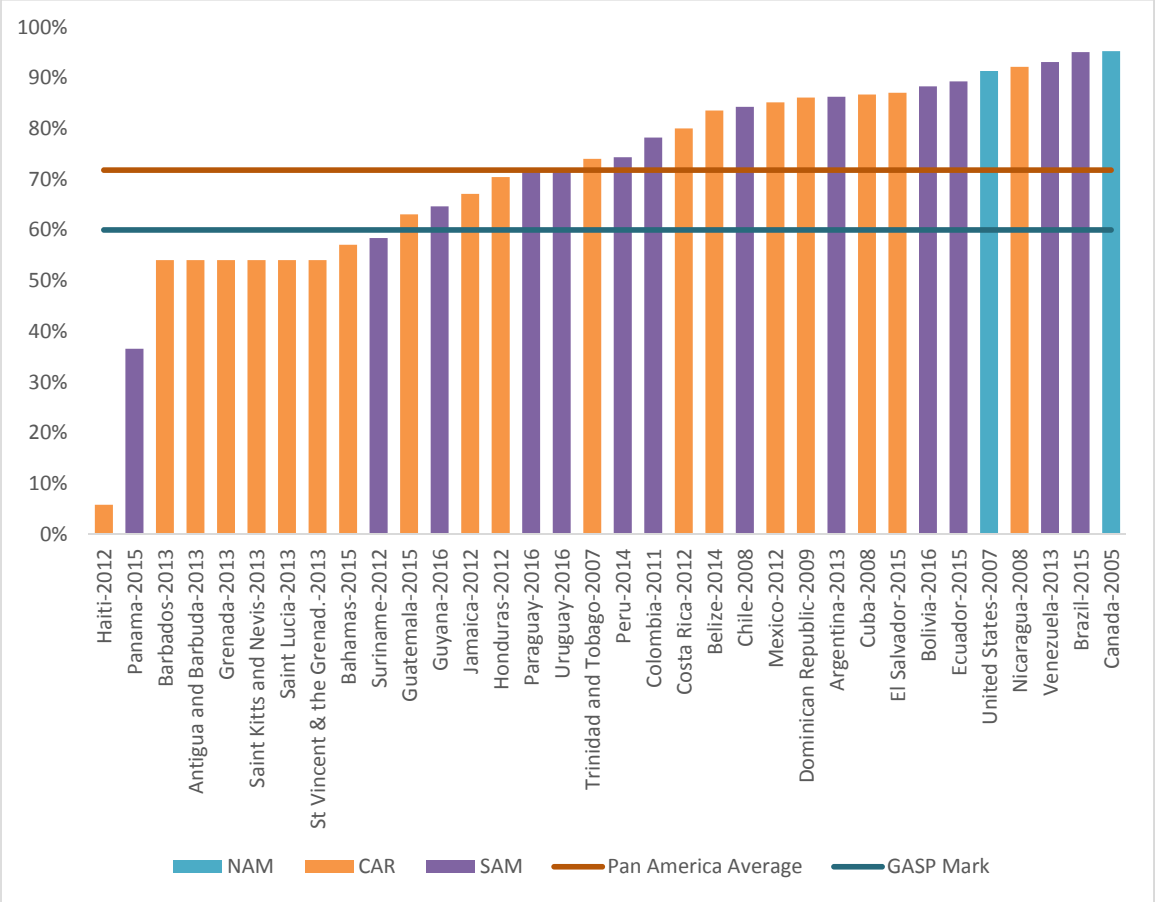


Figure 21 shows the average effective implementation in the Pan American Region, which increased from 65.2% in 2010 to 71.8% as of November 2016, achieved as result of the latest audits conducted to Argentina, Bahamas, Bolivia, Brazil, Colombia, Ecuador, Guyana, Mexico, Panama, Paraguay, Peru, Suriname, Uruguay and Venezuela. According to ICAO Global Aviation Safety Plan (GASP), States should target their efforts to increase and maintain effective implementation above 60%. In the Pan American Region, 13 of the States audited showed effective implementation below 60%, and the averages were 93.3% for the NAM Region, 66.5% for the CAR Region and 76.3% for the SAM Region.

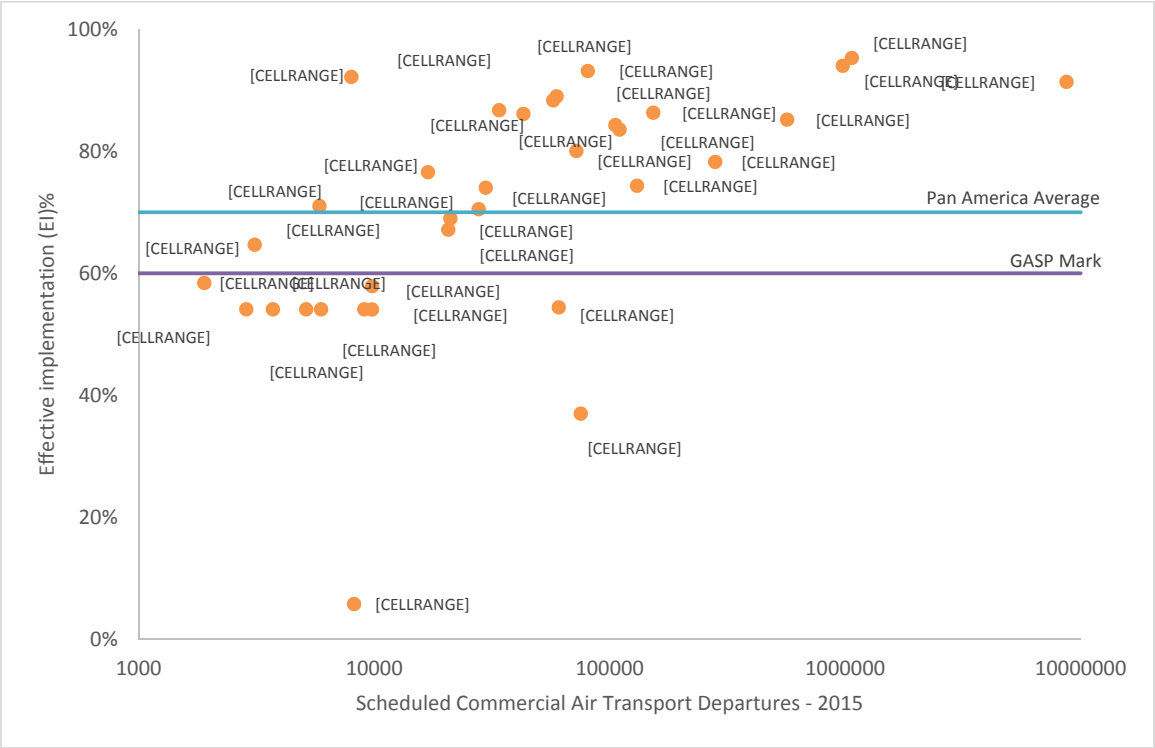
According to the ICAO Global Air Transport Outlook to 2030, forecasts for total Latin America and Caribbean passenger traffic call for an annual growth rate of 5.9% to 2030. By 2030, Latin America and Caribbean international markets are expected to account for 74% of the total passenger traffic from, to and within the region.

Considering the projected traffic growth, it is highly recommended that the CAR and SAM Regions continuously monitor and improve the implementation of the ICAO SARPs that could result in minimizing exposure to the associated risks derived from traffic growth, especially in the areas of ANS, AGA and AIG, and CE4.

Figure 22 shows a comparison between effective implementation (EI) and traffic volume (departures) by Pan American States in 2014, based upon ICAO iSTARS data.

Figure 22. Effective implementation vs. 2015 Departures by State (ICAO iSTARS)

UPDATED 10.JUN.2016



The chart above is intended to represent risk exposure of the States. Low levels of effective implementation associated with high traffic volume could indicate higher exposure to risk.

2.2 IOSA main findings per Top Risk Category

ENTIRE SECTION PENDING FOR UPDATE WHEN IOSA DATA AVAILABLE.

To assist operators to better understand the latent conditions related to the top high risk accident categories, IATA prepared a review of the IOSA Standards and Recommended Practices (ISARPs) related to Loss of Control In-flight, Controlled Flight into Terrain and Runway Excursion. The following figures present the top findings and observations associated with the relevant ISARPs, based upon global data.

a) Runway Excursion IOSA findings:

The primary findings for Runway Excursions related to the operators' requirements to ensure flight crew training in procedures for upset recovery and for windshear avoidance and recovery.

The following figure shows the findings detected during IOSA audits in the Pan American Region with regard to runway/taxiway excursions

Figure 23. IOSA Findings related to Runway/taxiway excursion per Region

b) Loss of Control In-Flight IOSA findings:

For flight operations, the most common findings were in the operators' requirements to ensure flight crew training in procedures for upset recovery and collision avoidance policies that encourage the flight crew to maintain vigilance for conflicting visual traffic.

The following figure shows the findings detected in this category per Region.

Figure 24. IOSA Findings related to LOC-I per Region

c) Controlled Flight Into terrain IOSA findings:

The primary findings for Runway Excursions related to the operators' requirements to ensure flight crew training in procedures for upset recovery and for windshear avoidance and recovery.

The following figure shows the findings related to CFIT per Region.

Figure 25. IOSA Findings related to CFIT per Region

2.3 IDISR Program

The Data Exchange Program of Ramp Safety Inspections (IDISR) is a reporting system designed to store, process and share information on ramp inspections conducted to foreign operators (under LAR 129) within the Member States of the Regional Safety Oversight Cooperation System (SRVSOP) which includes 11 States of the SAM Region and 1 from the CAR Region.

Since 2008 until 2015, IDISR recorded more than 4,000 inspections with an average of 0.43 findings per inspection. The following table presents a comparison of the last two years.

Table 11. 2015 IDISR general results 2014-2015

UPDATED 16.JUN.2016

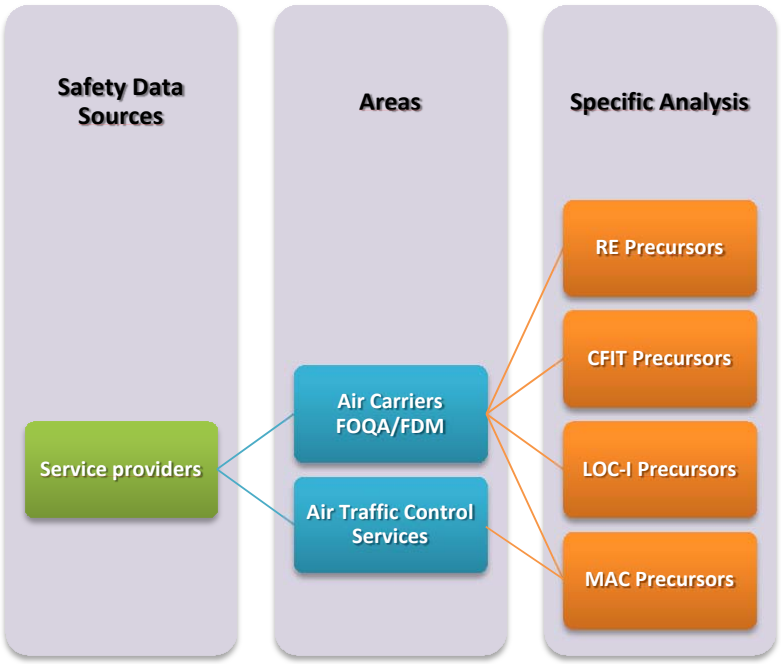
Year	Conducted inspections	Total findings	Rate of findings per inspection
2014	697	172	0.247
2015	930	476	0.512

Most common findings were related to the general condition of aircraft, operating procedures for dangerous goods and maintenance operations.

3 Predictive Safety Information

This section contains predictive safety information, which includes the analysis of FOQA/FDA events occurred in the CAR and SAM Regions that could reveal precursors of accidents. The following figure depicts the structure of the analysis presented in this section.

Figure 26. Predictive Safety Data Analysis



The analysis was conducted using data provided by the Flight Operations Quality Assurance (FOQA) system from different airlines that included operations in the CAR and SAM Regions within the last three years shared with RASG-PA under Memorandums of Understanding (MOUs).

Data sources to highlight for this analysis are IATA's Flight Data eXchange (FDX) program (which uses FOQA data provided by 26 Latin American airlines operating in the CAR and SAM Regions) and the CAR/SAM Regional Monitoring Agency (providing data with regard to Large Height Deviations, which provided data related to Large Height Deviations (LHD) in the RSVM space of the CAR and SAM Regions.

The main findings with regard to the top accident categories are:

a) Runway Excursion Precursors:

- Unstable approaches, hard landings, go arounds and high tailwind landings are RE precursors, all of them appearing to show improving trends during the analyzed time period.
- In the case of the CAR and SAM Regions, many of the unstable approaches were spread over a few aerodromes.
- IATA FDX showed a decreasing trend in the RE Precursors in the time period from January 2013 to December 2015, as presented in the following figure.

Figure 27. FDX Unstable Approach Rate Trend – CAR and SAM Regions

PENDING FOR UPDATE. FDX DATA REQUIRED

b) Controlled Flight Into Terrain Precursors:

- The analyzed FOQA data included Ground Proximity Warning System (GPWS) events as precursors to CFIT, appearing to show decreasing trends during the analyzed time period. The following figure shows the results of FDX analysis with regard to GPWS events trend.

Figure 28. FDX GPWS Rate Trend – CAR and SAM Regions

PENDING FOR UPDATE. FDX DATA REQUIRED

c) Loss of Control In-flight Precursors:

- Overbank excess and stall warning and maneuvering are under study as precursors of LOC-I. Both of them appear to show flat trends during the last three years.

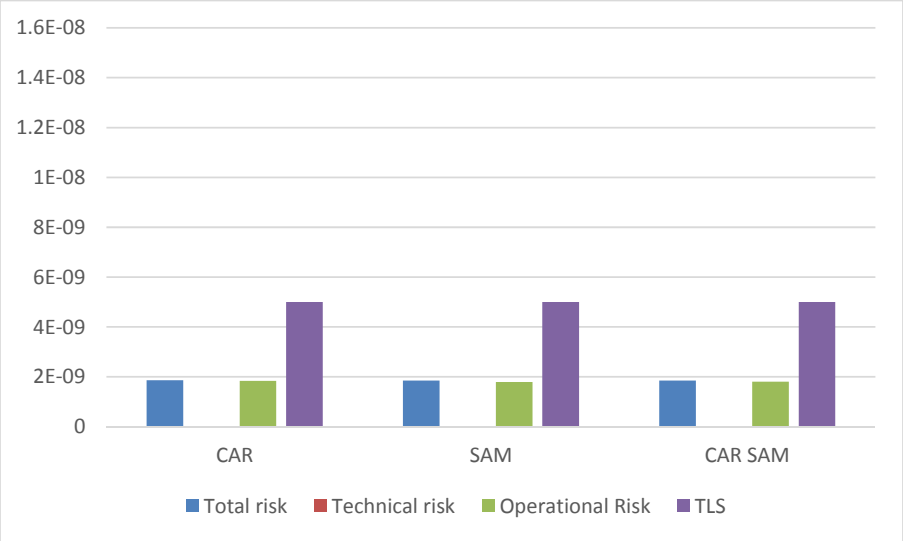
d) Mid Air Collisions Precursors:

- Traffic Alert and Collision Avoidance System Resolution Advisory (TCAS RA) events, which can be categorized as precursors of Mid-Air Collisions, showed decreasing trends throughout the last three years. FDX data is presented in the following figure.

Figure 29. FDX TCAS RA Event Rate Trend – CAR and SAM Regions

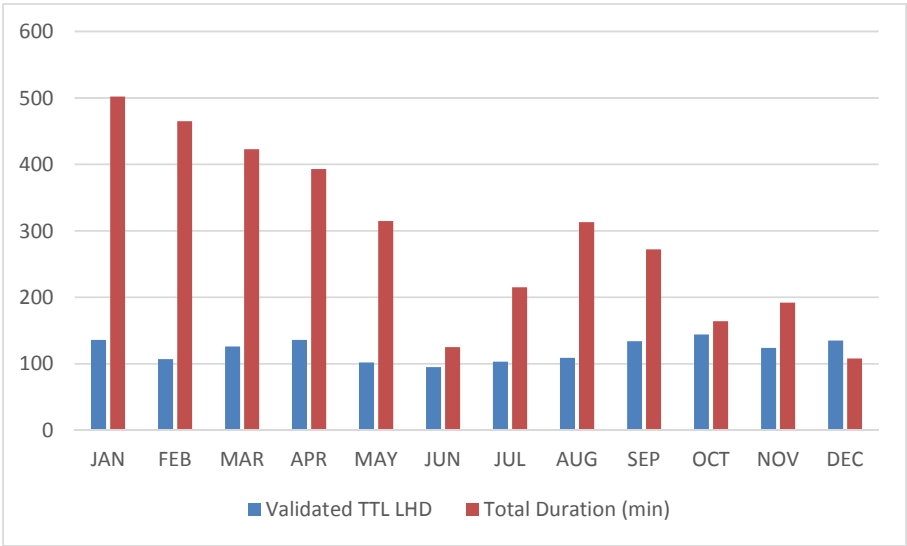
- According to CARSAMMA, as a result of actions taken by the States and ICAO, operations in RVSM airspace in the CAR and SAM Regions are within acceptable levels of risk, as shown by the validation of LHDs corresponding to 2014 (GTE/15 report). The calculated total risk in the CAR/SAM Regions is 1.85 x 10-9, way below the TLS, which is 5.0 x 10-9, as shown in the following figure.

Figure 30. Vertical collision risk in RSVM airspace for 2014



Actions taken by the States in coordination with ICAO have had an incremental impact on the reduction of validated LHDs, whose total duration, which is associated to severity, shows that the severity of events in the CAR and SAM Regions has dropped, as shown in the figure below.

Figure 31. Variation of LHDs in 2014, and severity based on duration in minutes



It should also be noted that, although figures way below the TLS have been obtained for the first time since RVSM implementation in 2005, there has been an improvement in the reporting culture among ATCs and pilots.

Second Part: Safety Intelligence

This part of the report is intended to present correlations and conclusions based on the analysis of the first part, increasing the frame of reference for safety decision making process.

a) Safety Intelligence based on reactive information

- Accidents in the Pan American Region showed a decreasing trend across the ten-year analyzed period (2006-2015). In 2015 the accident rate was lower than world average.
- The analyzed data also highlighted Loss of Control In-flight, Runway Excursion, Controlled Flight into Terrain and Mid-Air Collisions continue to be the top categories of interest in the Pan American Region. All of these categories showed decreasing trends across the period.
- Regulatory oversight was identified as the top latent condition for 2011-2015 accidents in North America, followed by technology and equipment and maintenance operations.
- In Latin America and the Caribbean, the top latent condition for 2011-2015 accidents were regulatory oversight, safety management and maintenance operations.

b) Safety Intelligence based on proactive information

- Low levels of effective implementation (EI) of the ICAO Standards and Recommended Practices exist for 13 States in the Pan American Region according to the ICAO Universal Safety Oversight Audit Programme Continuous Monitoring Approach (USOAP CMA).
- USOAP findings regarding qualification and training of technical staff (CE 4) in Air Navigation System (ANS) area where the most common in NAM Region, followed by and SAM Regions. Meanwhile, in the CAR Region main findings involved licensing and certification obligations (CE 6) related to Aerodrome and Ground Aids (AGA).
- Furthermore, the increase in regional traffic, coupled with low EI in Air Navigation Systems (ANS) and Aerodromes and Ground Aids (AGA) areas could generate higher exposure to risk, especially for the CAR and SAM Regions.
- A review of IOSA audits resulted in…
- IDISR program most common findings were related to the general condition of aircraft, operating procedures for dangerous goods and maintenance operations.
- IDISR program also showed an increase in both the number of inspections and the rate of findings per inspection in 2015. Further study should be conducted to determine correlations between these results and improvements of safety management and oversight processes at the level of the States.

c) Safety Intelligence based on predictive information

- Unstable approaches, hard landings, go arounds and high tailwind landings, identified as RE precursors, appear to show improving trends in the CAR and SAM Regions.
- With regard to the precursors of CFIT, Ground Proximity Warning System (GPWS) related events continue to be a concern, showing a decreasing trend in the CAR and SAM Regions.
- Overbank excess and stall warning and maneuvering are under study as precursors of LOC-I. Both of them appear to show flat trends in the period.
- Traffic Alert and Collision Avoidance System Resolution Advisory (TCAS RA) events, which can be a precursor of Mid-Air Collision showed decreasing trend in the CAR and SAM Regions.
- With regard to Large Height Deviation (LHD) events, CARSAMMA data showed operations in RVSM airspace in the CAR and SAM Regions were within acceptable levels of risk during 2014, and the severity of events in the CAR and SAM Regions dropped throughout the year.

d) Safety Intelligence correlations

- Accidents and their proactive and predictive precursors, presented in the first part of the report allow to have a perspective of the entire aviation system about safety. In order to manage safety in an efficient manner, it is important to maintain reliability in safety information and

intelligence, which is only achievable by keep developing and improving safety data gathering, validation, exchange and analysis processes.

- According to Annex 13th to the Convention on International Civil Aviation, near collisions requiring evasive maneuvers are considered serious incidents. Nevertheless, when comparing TCAS RA data and MAC reported occurrences it was seen a significant difference in the numbers. There should be interesting to conduct further analysis to determine if this difference is related to incident reporting and investigation policies at the level of the States, and also if there is a relationship to USOAP critical elements in OPS and AIG areas.
- IDISR program found maintenance activities amongst the most common findings during ramp inspections. It should be interesting to explore their correlation to the behavior of latent conditions identified by IATA regarding Standard Operation Procedures (SOPs) and checking during maintenance operations, especially in CAR and SAM Regions.
- Another latent condition identified in 2015 accidents by IATA was related to regulatory aspects. Eventhough there appears not to be a direct correlation with USOAP most common findings, it is recommended to conduct an in-depth study to improve safety decision making.

List of Acronyms

ADREP	Accident/Incident Data Reporting System (ICAO)
ADRM	Aerodrome
AFI	Africa (IATA Region)
AIS	Aeronautical Information Service
AMAN	Abrupt manoeuvre
ARC	Abnormal runway contact
ASPAC	Asia/Pacific (IATA Region)
ASRT	Annual Safety Report Team
ATM	Air Traffic Management, Communications, Surveillance
BIRD	Birdstrike
CABIN	Cabin safety events
CAR	Caribbean (ICAO Region)
CAST	Commercial Aviation Safety Team
CEs	Critical Elements (ICAO)
CFIT	Controlled flight into terrain
CGO	Cargo Operations (IOSA)
CIS	Commonwealth of Independent States (IATA Region)
CMA	Continuous monitoring approach
DGAC	Directorate General of Civil Aviation
DIPs	Detailed Implementation Plans
ECCAIRS	European Coordination Centre for Accident and Incident Reporting Systems
E-GPWS	Enhanced Ground Proximity Warning System
EI	Effective Implementation of ICAO SARPs
EUR	Europe (ICAO and IATA Region)
EVAC	Evacuation
FDA	Flight Data Analysis
FLT	Flight Operations (IOSA)
F-NI	Fire/smoke (none-impact).
FOQA	Flight Operations Quality Assurance
F-POST	Fire/Smoke (post-impact)
FUEL	Fuel related
GASP	ICAO Global Aviation Safety Plan
GCOL	Ground collision
GPWS	Ground Proximity Warning System
GRH	Ground Handling Operations (IOSA)
GSI	Global Safety Initiative
ICAO	International Civil Aviation Organization
ICE	Icing
IMC	Instrument meteorological conditions
IOSA	IATA Operational Safety Audit
ISTARS	ICAO Integrated Safety Trend Analysis and Reporting System
LALT	Low altitude operations
LATAM/CAR	Latin America and Caribbean (IATA Region)
LOC-G	Loss of control - ground
LOC-I	Loss of control - inflight
MAC	AIRPROX/TCAS alert/loss of separation/near miss collisions/mid-air collisions
MNT	Aircraft Engineering and Maintenance (IOSA)
MENA	Middle East and North Africa (IATA Region)
MTOM	Maximum Take-off Mass
NAM	North America (ICAO and IATA Region)
NASIA	North Asia (IATA Region)
OTHR	Other
ORG	Organization and Management System (ORG)
PA-RAST	Pan America – Regional Aviation Safety Team
RA	Resolution Advisory
RAMP	Ground handling operations
RASG-PA	Regional Aviation Safety Group – Pan America
RE	Runway excursion (departure or landing)
RI	Runway Incursion
RI-A	Runway Incursion – Animal
RI-VAP	Runway Incursion – vehicle, aircraft or person
SAM	South America (ICAO Region)
SARPS	Standards and Recommended Practices (ICAO)
SEC	Security Management (IOSA)
SEIs	Safety Enhancement Initiatives
SCF-NP	System/component failure or malfunction (non-powerplant)
SCF-PP	Powerplant failure or malfunction
SEC	Security-related
SOP	Standard Operating Procedure
SRVSOP	Regional Safety Oversight System
TCAS	Traffic Collision and Avoidance System
TCAS RA	Traffic Collision and Avoidance System-Resolution Advisory
TEM	Threat and Error Management
TURB	Turbulence encounter
UNK	Unknown or Undetermined
USOAP	Universal Safety Oversight Audit Programme
USOS	Undershoot/Overshoot
WSTRW	Wind shear or thunderstorm

CREDITS – CRÉDITOS

RASG-PA thanks the members of the RASG-PA Annual Safety Report Team (ASRT) that contributed to the elaboration of this RASG-PA Annual Safety Report – Fifth Edition.

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