

ANNUAL SAFETY REPORT



2022

TWELFTH
EDITION

RASG-PA

Information produced with data from 2012 until 2021

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Foreword

The Regional Aviation Safety Group – Pan America (RASG-PA) was established in November 2008 with a vision to remain ahead of any risks to commercial aviation, seeking to achieve the highest level of safety in the Pan American Region, as well as addressing global aviation safety matters from a regional perspective.

RASG-PA membership includes representatives from all States/Territories of the International Civil Aviation Organization (ICAO) North American (NAM), Caribbean (CAR) and South American (SAM) Regions, international organizations and industry. ICAO serves as the group Secretariat, providing administrative, coordination and technical support to the RASG-PA, its working groups, and committees.

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, allowing for a consolidated vision of the main areas of interest for the development of safety improvement actions, tailored to the realities 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

Executive Summary

The results of the analysis of regional aviation safety data indicate an alignment with the content of the 2020-2022 GASP edition and pertinent ICAO documentation. When fatal occurrences are classified, four high risk categories (HRCs) were considered the most significant for the Pan American Region operational context, which led the analysis of regional aviation safety data to focus safety enhancement initiatives (SEIs) in the following issues:

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

In addition to the four SEIs, ASR 2021 recommended that occurrences involving turbulence and severe weather (TURB) should be assessed and their risks duly addressed by PA-RAST as an additional risk category. The reactive information analysis showed a great disparity among regions regarding TURB events reporting, which can indicate a geographically concentrated safety issue or can reflect an asymmetry in protocols, standards and procedures concerning mandatory and voluntary occurrence reporting in this specific matter.

According to the statistics contained in this report, the number of accidents in 2021 in the Pan American Region (ICAO NAM, CAR and SAM) for scheduled commercial air transport operations involving aircraft with maximum take-off mass (MTOM) above 5,700 kilograms and its respective accident rate increase compared to 2020, which could be understood due to the increase in operations when the restrictions due to the COVID-19 pandemic were lifted.

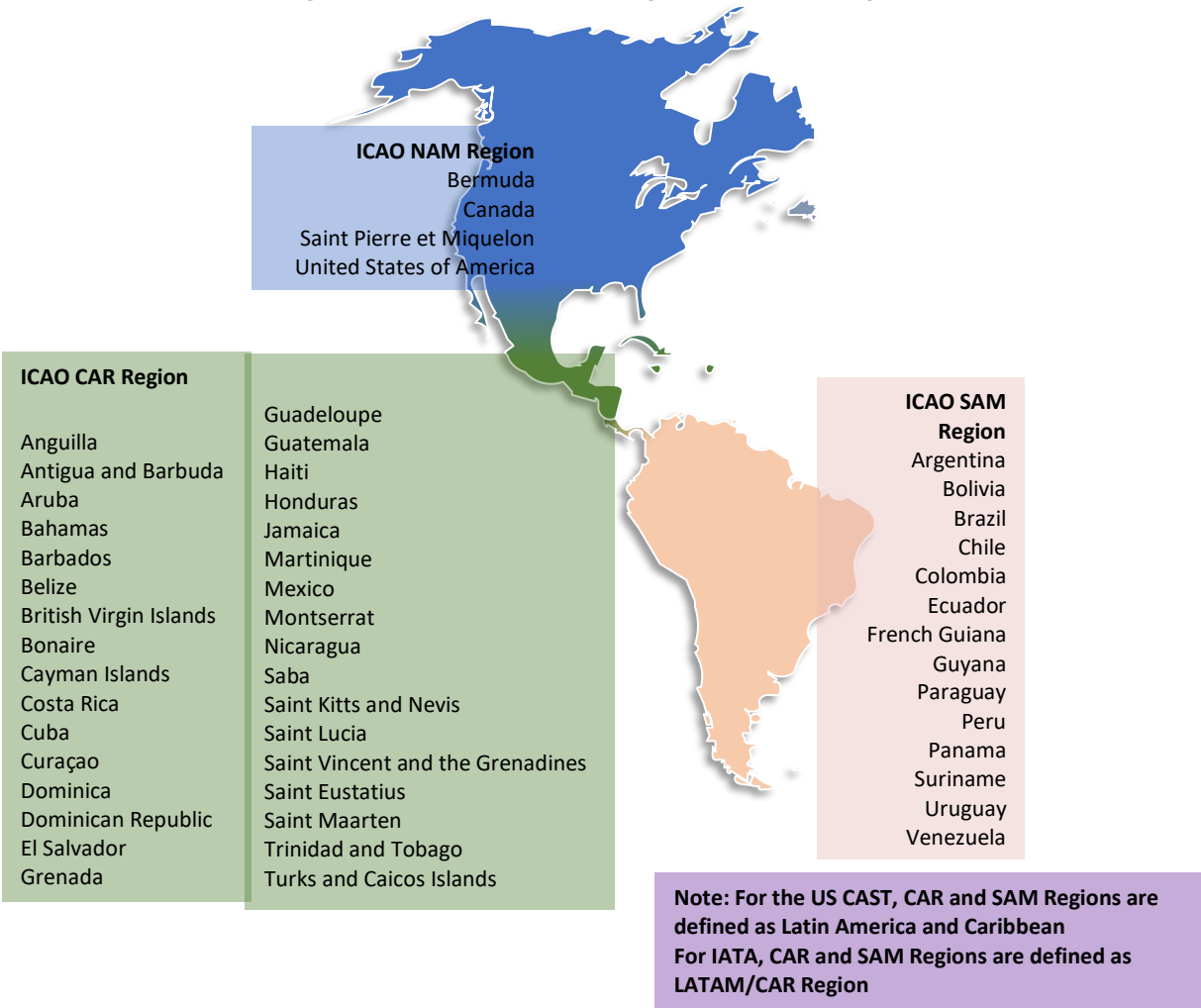
In this utterly new operational scenario, the four SEIs continue to show decreasing trends through the latest ten-year period, as can be seen from the analysis of the reactive data. However, any reduction observed in accident and fatality rates in the Reactive Safety Information of ASR 2021 cannot be taken as a long-time trend or to an improvement observed by auditing, but probably as a result of a significant change in the operational scenario faced by operators and other stakeholders.

Despite the recent demand retraction for air transport services caused by COVID-19 pandemic, the most recent air traffic projections still attribute remarkable commercial traffic growth for CAR and SAM Regions, which reinforces the necessity to improve ANS and AGA areas. The analysis conducted to determine correlations between the critical elements (CEs) of an effective safety oversight system and areas of the ICAO Universal Safety Oversight Audit Programme - Continuous Monitoring Approach (USOAP-CMA) strengthens this recommendation, since it showed that main findings in the case of CAR and SAM Regions were also related to CE 6, but specifically in the Aerodrome and Ground Aids (AGA) area, related to aerodrome data, runway safety areas and runway incursion and collision avoidance.

About the report

The principal objective for publishing this report is to highlight its usefulness as a safety intelligence tool, by focusing on the main aviation safety areas of interest in the Pan American Region, incorporating an integrated vision from different stakeholders. The improvements in every new edition of the Annual Safety Report are oriented to facilitate the comprehension of the methodologies, data analysis tools, and other information necessary to implement safety management activities, plans and programs to ensure risk mitigation in the aviation sector.

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



How this report is structured

The report is structured in two parts:

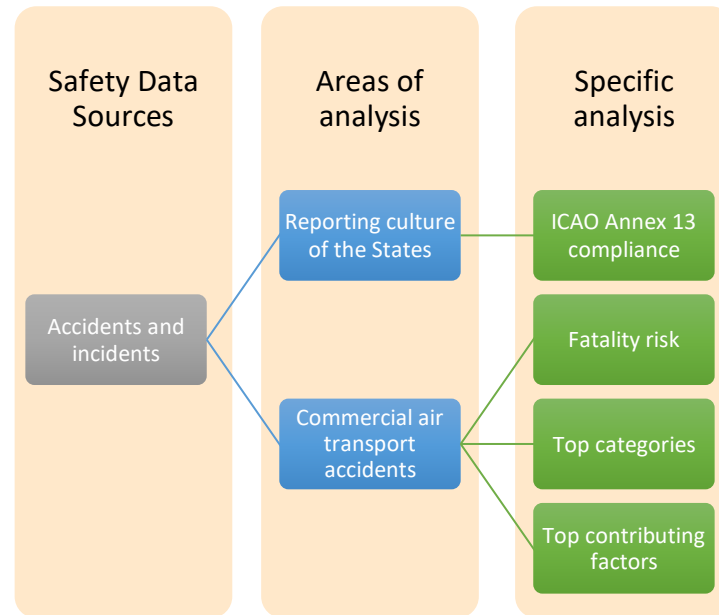
Part One: Safety Information

The first part of the report is oriented to present relevant safety information, according to aviation safety management principles¹, which state that hazards can be identified using two distinct methodologies:

¹ ICAO Annex 19 and Document 9859

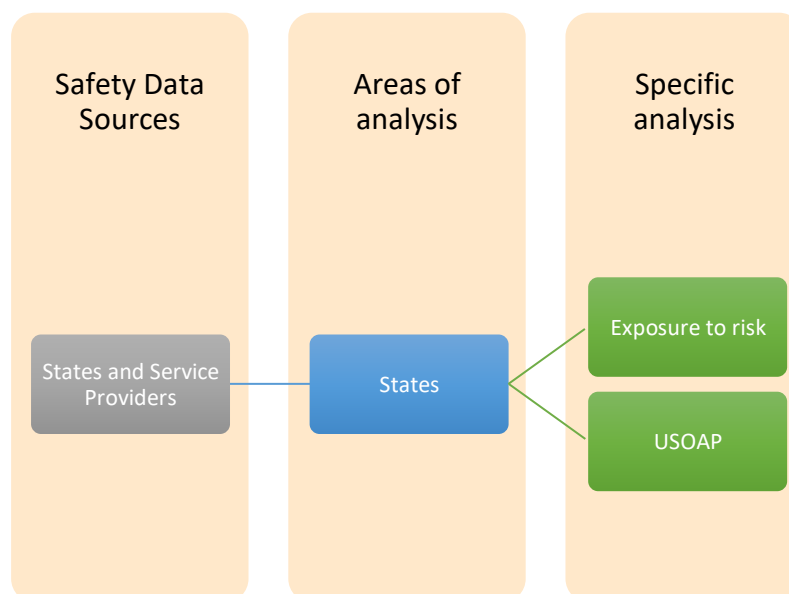
1. **Reactive:** Refers to the analysis of results or past events. Through investigation processes, hazards contributing to accidents or incidents can be identified. In this report, the reactive section presents safety analysis based upon accidents and incidents, as shown in the following figure.

Figure 3. Reactive Safety Data Analysis



2. **Proactive:** Refers to the analysis of existing conditions. Safety assurance processes, such as audits or evaluations, can provide information on hazards in the processes in place. The proactive section of this report includes analysis of audit results for the States (ICAO Standards and Recommended Practices implementation, traffic) and service providers as IOSA (IATA Operational Safety Audits).

Figure 4. Proactive Safety Data Analysis



Part Two: Safety Intelligence

The second part of the report reflects the use of the data analysis results to develop safety intelligence, establishing correlations to facilitate the decision-making process and for the benefit of aviation safety.

Sources of information

Information is only as good as the sources from which it is obtained. To be valid and included in the Annual Safety Report, the information used requires the existence of processes to assure data quality and traceability.

Every stakeholder has a specific approach and uses distinct indicators to measure aviation safety. A goal of the Annual Safety Report is to highlight the main common areas of interest, providing a context in which joint efforts could allow better resources allocation and significant improvement of safety.

Currently, the Annual Safety Report is only possible by the in-kind contribution of the Commercial Aviation Safety Team from United States (US CAST), Boeing, the International Air Transport Association (IATA) and ICAO, who provide the safety information supporting the identification of areas of interest for aviation safety with an integrated view. Other stakeholders are invited to contribute to aviation safety by providing useful information for the Annual Safety Report, or by participating in the RASG-PA, its work groups and committees.

Interacting with the Annual Safety Report

As mentioned previously, the Annual Safety Report is intended to show the behavior of aviation safety at a regional level, with a consolidated perspective amongst the stakeholders.

Users of the Annual Safety Report are invited to apply the proposed methodology; to establish a starting point or a mechanism to improve safety data management by consolidating relevant information from different sources, and by deepening the analysis of the exposed areas, to be more representative of their specific reality and context.

Part One: Safety information

1. Reactive Safety Information

Using the reactive methodology, this section is intended to assist with comprehending the behavior of Safety in the Pan American Region, based upon the analysis of accidents and incidents, according to the data provided by the US CAST, Boeing, IATA and ICAO.

It is important to note that each stakeholder captures a specific portion of data and develops metrics applicable to areas of interest. The Annual Safety Report challenge is to identify and apply the data to allow for a cross-sectional understanding of safety, thus overcoming individual limitations. To develop the metrics in this report, commercial aviation accidents data, gathered and processed by the different stakeholders was considered, according to the following criterions.

- ICAO data on accidents, serious incidents and incidents occurred during scheduled commercial air transport operations, involving aircraft with maximum takeoff mass above 5,700 kg, classified by State of Occurrence. The analyzed time frame was 2012-2021.
- Accidents occurred from 2012 to 2021 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, provided by the US CAST.
- IOSA results and accidents involving fixed-wing aircraft over 5,700 kg with jet or turboprop propulsion engaged in commercial operations, in the time period 2017-2021, provided by IATA.

1.1 Pan American accident statistics and rates

According to ICAO data, 27 accidents during regular commercial air transport operations, involving aircraft above 5,700 kilograms occurred in Pan America, none of those accidents resulted in fatalities.

The distribution of 2021 global accidents, fatal accidents and fatalities by RASGs (Regional Aviation Safety Groups) is shown in Table 1. Also, Table 2 shows the specific values for the Pan American Region.

Table 1. Accident Statistics and Accident Rates – 2021

RASG	Estimated Departures	Number of accidents	Accident rate (per million departures)	Fatal accidents	Fatalities	Share of Traffic	Share of Accidents
AFI	651 962	1	1,53	1	10	2,7%	2,2%
APAC	8 103 984	6	0,74	1	62	33,7%	13,0%
EUR	4 747 452	12	2,53	2	32	19,7%	26,1%
MID	797 843	0	0,00	0	0	3,3%	0,0%
PA	9 762 487	27	2,77	0	0	40,6%	58,7%
WORLD	24 063 732	46	1,91	4	104	100%	100%

Table 2. Scheduled Commercial Air Transport Accidents occurred in Pan America (2012-2021)

Year	Total Accidents	Fatal accidents ²	Total fatalities
2012-2021 avg.	37	1,2	14
2021	27	0	0
2020	19	0	0

In 2021 the number of total accidents and total fatalities was lower than the 10-year average. Some of this reduction can be attributed to the significant changes caused in the operational scenario by the COVID-19 pandemic (see Table 3 - air transport departures per Region), that led to an utter modification in flight routes distribution, airport structure utilization, ramp activities, among other factors.

During the 2012-2021 period a total of 12 fatal accidents occurred, where 2 occurred in the NACC region and 8 in the SAM region. For that period of time, according to the information provided by ICAO iSTARS system, the scheduled traffic by region (in millions of departures) was: 10.283 M for the CAR region, 18.107 M for SAM region and 98.055 M for NAM region.

When 2021 is compared to 2020, scheduled traffic increased 31,1% in SAM, and 35,6% in NACC, as can be seen in Table 3. Most of this increase can be attributed to some flexibility measures COVID-19 pandemic. In the last months, the governments of the region have increased the opening of flights and the passengers have started traveling despite the necessary biosecurity measures, which led to a gradual increase in commercial air transport activities.

Table 3. Scheduled Commercial Air Transport Departures (in millions) – by Region (2020-2021)

Region	2020	2021	Variation (%)
NACC	6,340	8,598	35,6
SAM	0,888	1,164	31,1
PA Region	7,228	9,762	35,1

Table 3. Scheduled Commercial Air Transport Departures (in millions) – by Region (2019-2020)

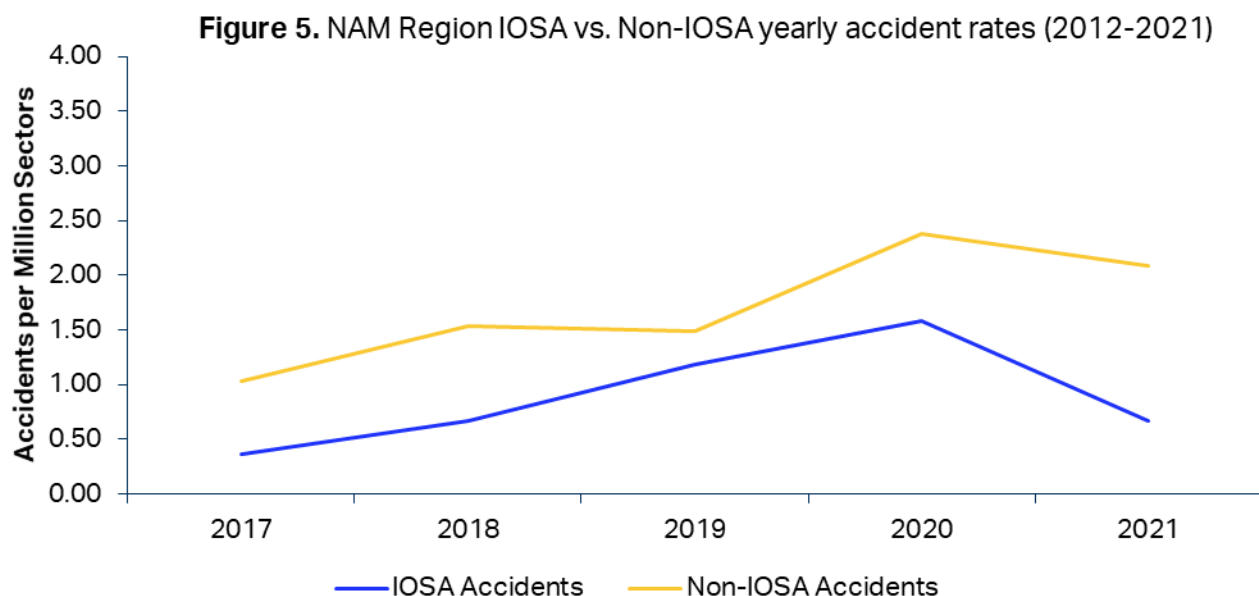
Region	2019	2020	Variation (%)
NAM	10.67	6.34	-40,6
CAR	1.22	0.80	-34,6
SAM	1.94	0.88	-54,1
PA Region	13.83	8.02	-41,9

The growth in scheduled air transport departures, covers all Pan American Region. The Pan American Region, thus, faces a great challenge, once it is expected that specific risks will emerge during the recovery from COVID-19, specially because the steep drop in air transport demand might be followed by a steep increase, which affects, among other sectors, flight crew and air traffic management training, aerodrome infrastructure maintenance and ramp activities, as well as safety oversight activities by the States.

1.2 NAM Region Analysis

1.2.1 IATA Operational Safety Audit (IOSA) summary

The comparison of the number of recorded accidents per million sectors flown for IOSA registered airlines versus non-IOSA registered airlines in the NAM Region, indicated significantly lower rates for IOSA registered operators, as shown in the following figure. No fatalities in the NAM region in 2021, the rates were both zero for fatal accidents.



1.2.2 Contributing Factors to 2017-2021 Accidents

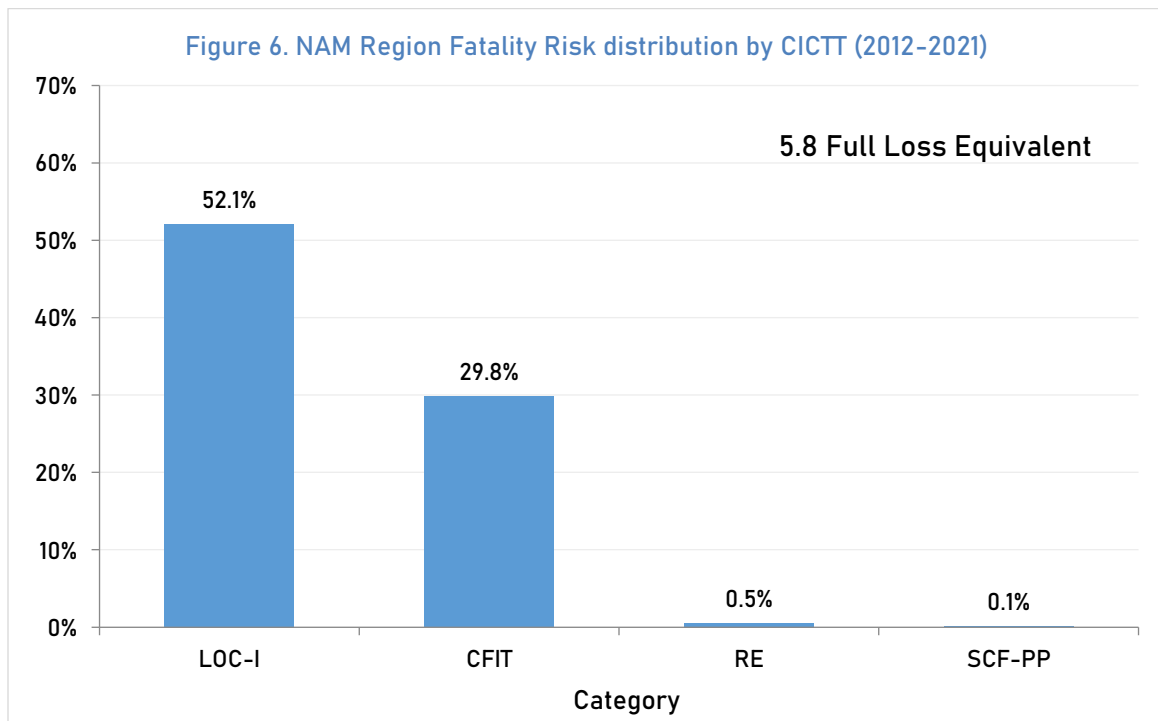
Using a classification model based on the Threat and Error Management (TEM) framework, IATA identified contributing factors to NAM 2017–2021 accidents, as follows.

Table 4. Top Contributing Factors to NAM accidents (2017–2021)

Latent conditions	Safety Management (25%) Regulatory Oversight (22%) Flight Operations (20%) Maintenance Operations (15%) Selection Systems (11%) Flight Ops: Training Systems (9%)
Threats (Environmental)	Meteorology (36%) Wind/Windshear/Gusty wind (27%) Contaminated Runway/Taxiway - poor braking action (11%) Poor visibility / IMC (11%) Thunderstorms (9%)
Threats (Airline)	Aircraft malfunction (22%) Gear/Tire (13%) Airport Facilities (13%) Maintenance Events (11%)
Flight Crew Errors	Manual Handling / Flight Controls (44%) SOP Adherence / SOP Cross-verification (27%) Pilot-to-pilot communication (11%) Failure to GOA after Destabilization on Approach (11%)
Undesired Aircraft States	Long/floated/bounced/firm/off-center/crabbed land (24%) Abrupt Aircraft Control (20%) Vertical / Lateral / Speed Deviation (16%) Unstable Approach (11%) Operations Outside Aircraft Limitations (9%) Continued Landing After Unstable Approach (9%)
Countermeasures	Overall Crew Performance (24%) Monitor/Cross-check (18%) Leadership (15%) Captain should show leadership (13%) In-flight Decision-making/contingency management (7%)

1.2.3 Fatality risk

The US CAST utilizes a model to determine fatality risk associated with accidents . For this analysis, accidents are classified in categories, based on specific characteristics of each occurrence, consistent with ADREP Taxonomy. According to the information obtained from the ICAO-ADREP system, the distribution of fatality risk in 2012-2021 accidents affecting Operators located on the NAM regions presented in the following chart.

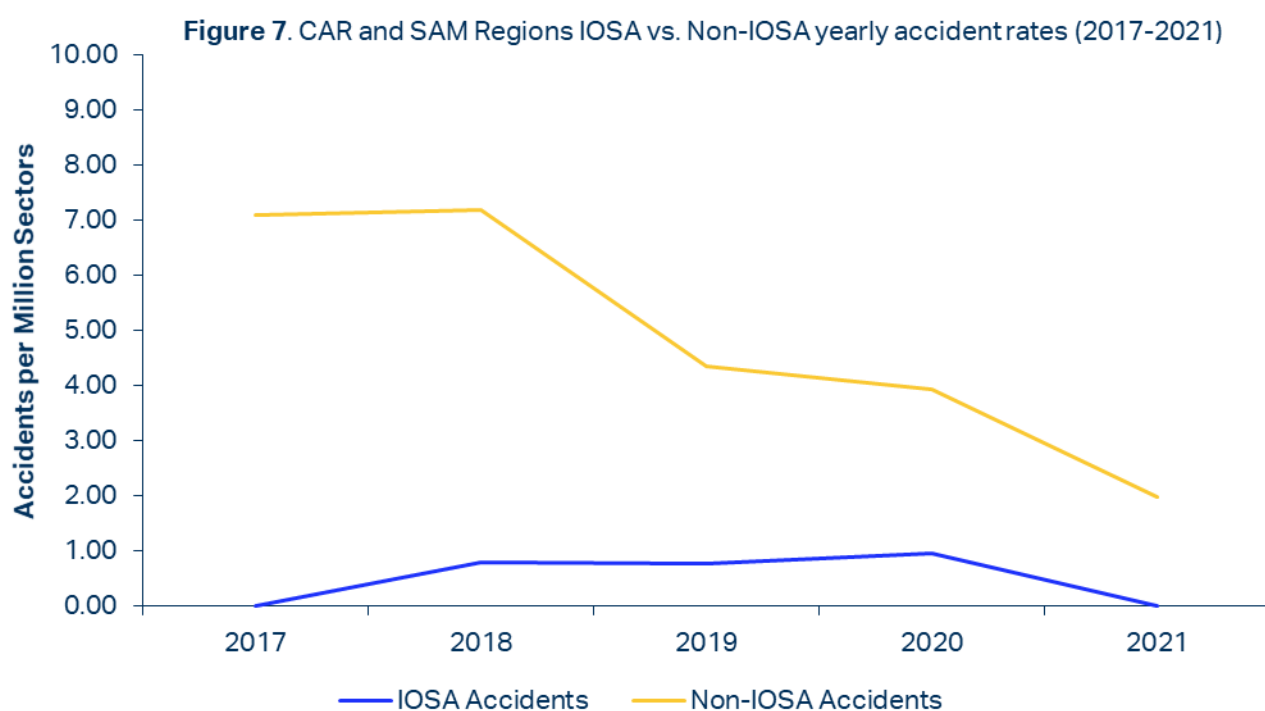


1.3 CAR and SAM Regions Analysis

Because of the ways of gathering and processing data made by the different stakeholders, in many cases it is not possible to separate CAR and SAM Regions data.

1.3.1 IATA Operational Safety Audit (IOSA) summary

The comparison of the number of recorded accidents per million sectors flown for IOSA registered airlines versus non-IOSA registered airlines in the Latin America and Caribbean IATA (LATAM/CAR) Region, indicated significantly lower rates for IOSA registered operators, as shown in the following figure. No fatalities in LATAM/CAR region in 2021, the rates were both zero for fatal accidents.



1.3.2 Contributing Factors to 2017-2021 Accidents

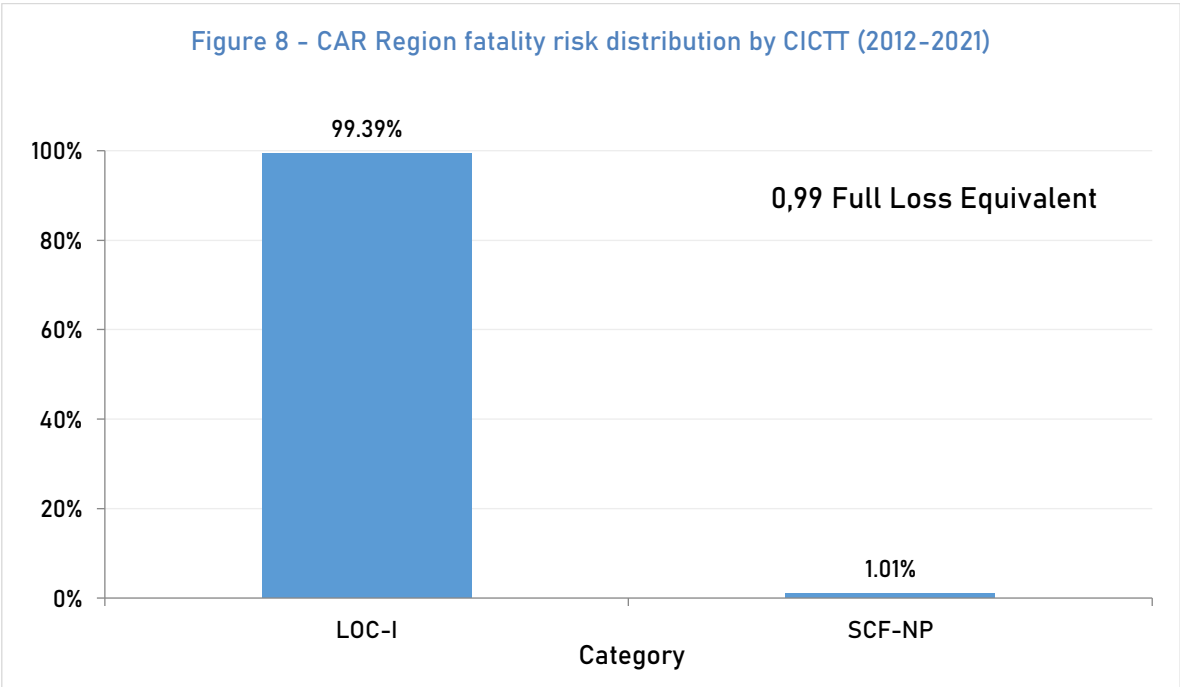
IATA identified the top contributing factors to CAR and SAM Regions 2017-2021 accidents, as follows.

Table 5. Top Contributing Factors to CAR and SAM accidents (2017-2021)

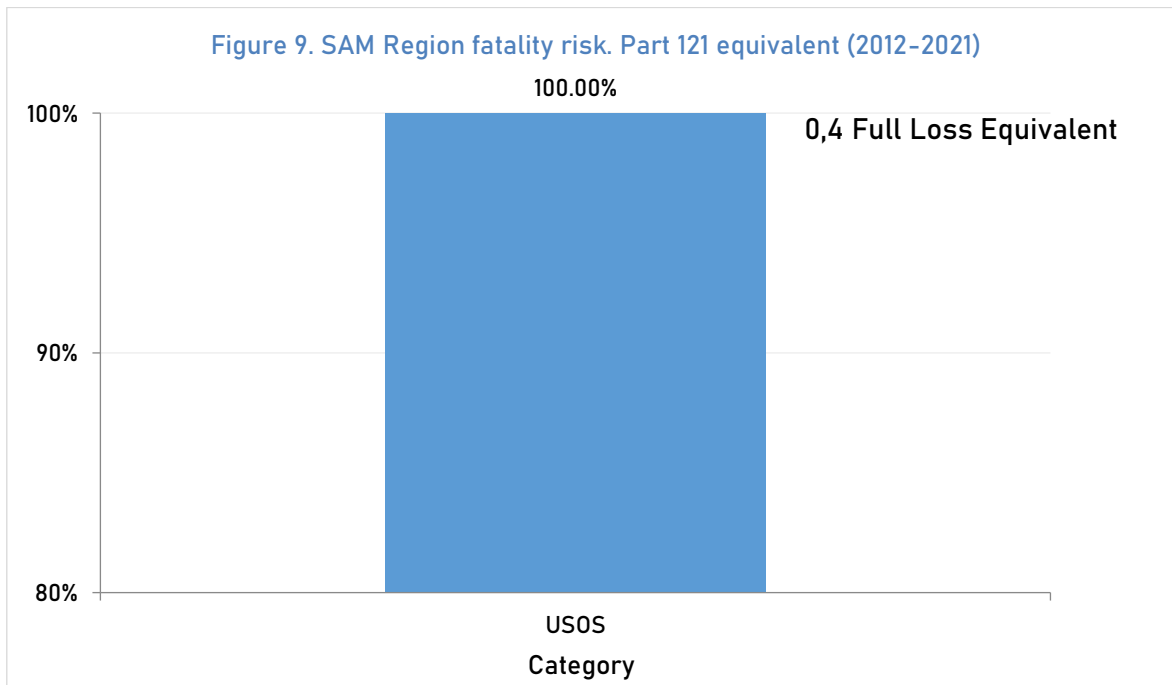
Latent conditions	Regulatory Oversight (38%) Safety Management (29%) Flight Operations (25%) Selection Systems (25%) Maintenance Operations (17%) Maintenance Ops: SOPs & Checking (17%)
Threats (Environmental)	Meteorology (21%) Wind/Windshear/Gusty Wind (13%) Thunderstorms (8%) Poor visibility/IMC (8%) Nav Aids (4%)
Threats (Airline)	Aircraft Malfunction (42%) Maintenance events (25%) Gear/Tire (25%) Dispatch/Paperwork (13%) Operational pressure (8%)
Flight Crew Errors	Manual Handling / Flight Controls (17%) SOP Adherence / SOP Cross-verification (13%) Documentation (8%) Wrong Weight & Balance/Fuel Information (8%) Callouts (4%)
Undesired Aircraft States	Abrupt Aircraft Control (13%) Unnecessary Weather Penetration (13%) Operation Outside Aircraft Limitations (13%) Weight & Balance (8%) Vertical/Lateral/Speed Deviation (8%) Long/Floated/Bounced/Firm/Off-center/Crabbed Landing (8%)
Countermeasures	in-flight Decision-making/Contingency Management (17%) Overall Crew Performance (13%) Monitor / Cross-check (13%)

1.3.3 *Fatality risk*

According to the information provided by The US CAST, the distribution of fatality risk for the accidents occurred within the 2012-2021 period affecting Operators with domicile in the CAR and SAM Regions, is shown in the following figures².



² See List of Acronyms on page 32 of this report



1.3.4 Accident data in the SAM Region

The States of the SAM Region implemented the AIG Regional Coordination Mechanism (ARCM), in order to enhance regional accident and incident investigation and the related data. At the time of this version of the Annual Safety Report, the European Coordination Centre for Accident and Incident Reporting Systems (ECCAIRS) has been implemented in the States of the SAM Region, and standardization and quality processes are under development.

1.3.5 AIG mechanisms in the CAR region

The States of the CAR region continue to seek regional collaboration to improve their level of compliance with accident and incident investigations (AIG), although it was previously commented that the RAIO was part of this approach, the creation of cooperation mechanisms may for now be the way to later form a RAIO.

In Central America, the Central American Regional Aviation Accident Investigation Group (GRIAA) a regional collaboration group among the six Central American States (Guatemala, Belize, El Salvador, Honduras, Costa Rica and Nicaragua) had been established. Under the support of the Caribbean Aviation Safety and Security Oversight System (CASSOS) a similar approach for the Caribbean (RAIO-C) to be implemented by CASSOS member States is being discussed.

Together with these, Regional collaboration agreements among AIG entities had been established for the exchange of resources, best practices and training matters: GRIAA – Transportation Safety Board from Canada (TSB), CASSOS – TSB, GRIAA – ARCM, Aviation Accident Investigation Commission from Dominican Republic (CIAA) – Mexico AIG – GRIAA.

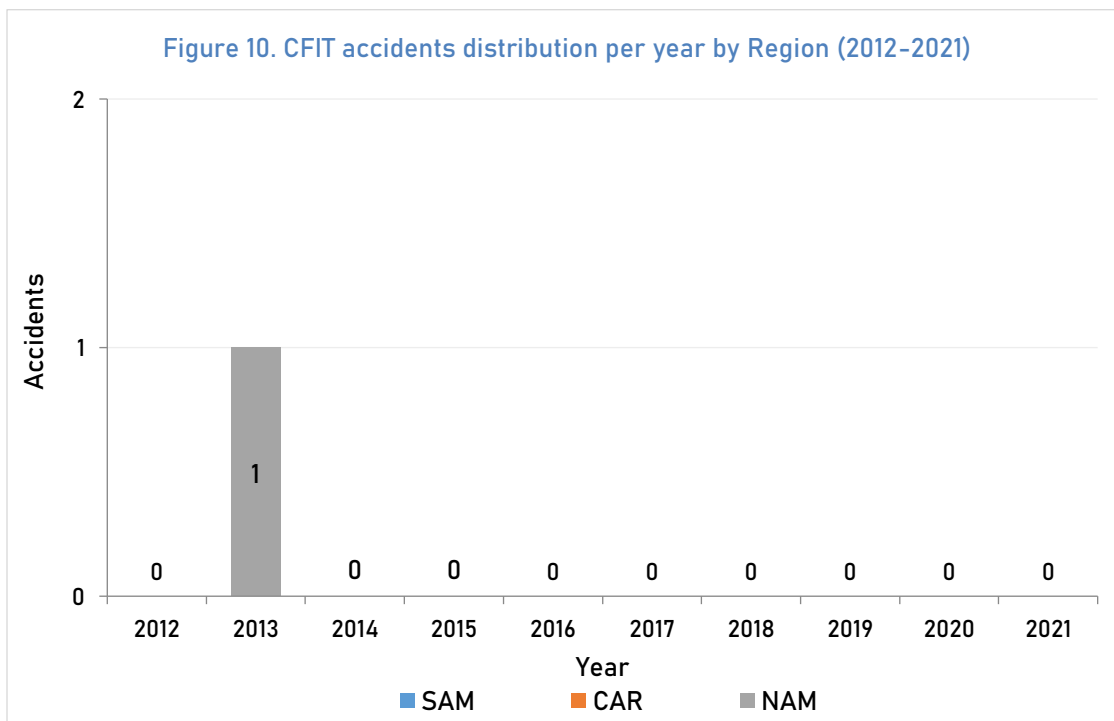
1.4 Specific analysis

After the determination of the most significant fatal accident categories for the Pan American Region was made, based on a fatality risk distribution by category of occurrence, the results were considerably aligned with the content of 2020-2022 GASP edition, from which four out of five high risk categories (HRCs) were considered the most significant for the Pan American Region operational context - CFIT, LOC-I, MAC and RE. Then, a more in-depth analysis was performed to determine the behavior and recurrent aspects of each category to be considered in the safety decision making process. As recommended by ASR 2020, also the TURB occurrences, that mostly involve events with severe weather conditions and turbulence involved, were analyzed, once TURB can be considered, in Pan American Region, an additional risk category (ARC).

Because of the COVID-19 pandemic and the steep drop in schedule flight departures and, as expected, the absolute number of accidents, it can be seen in Appendix A that there is a slight decreasing trend in the total number of accidents, but it must remain clear that, according to the proactive data gathered by RASG-PA, that does not represent necessarily a long-time trend when it comes to all types of occurrences. When only accidents among the HRCs categories are analyzed, there is a significant decreasing trend that was observed in the past reports and continues in 2020 in the Pan American Region, as described in sections 1.4.1 to 1.4.4.

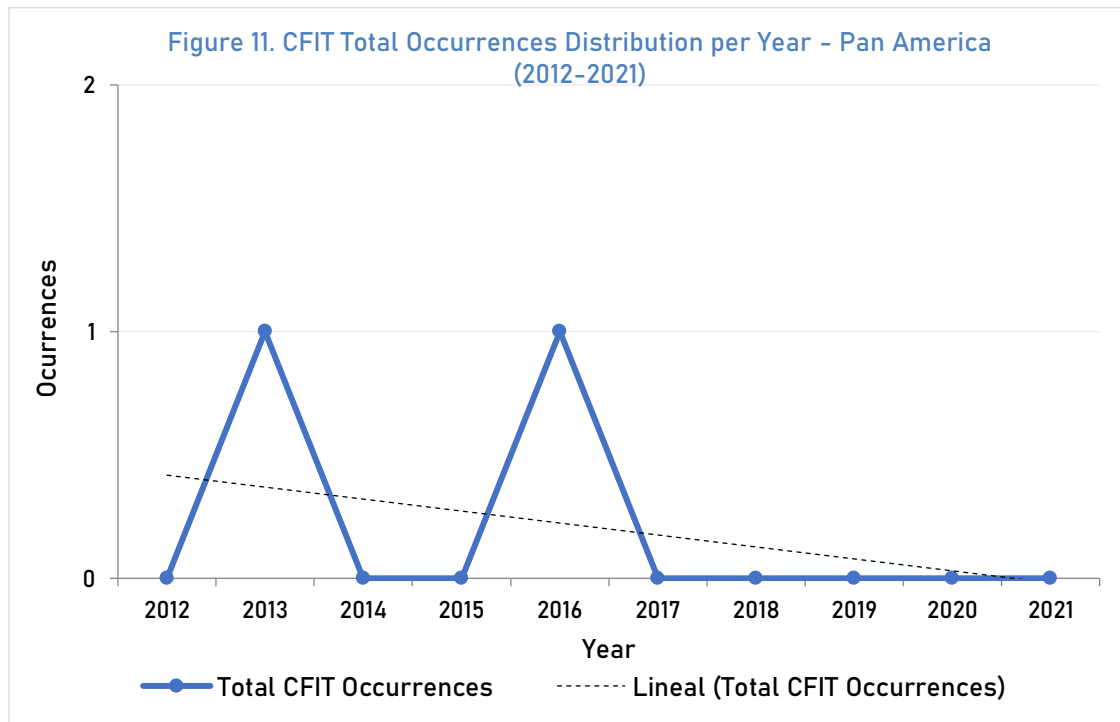
1.4.1 Specific analysis of Controlled Flight Into Terrain

Accidents recorded by ICAO show a decreasing trend in the Pan American Region, as presented in the following figure.



Accident, serious incident and incident data provided by ICAO, showed an average of 0.1 total occurrences in the Pan American Region within the latest 10-year moving average (2012-2021), with a

decreasing trend. The specific numbers of CFIT occurrences per year are presented in the following figure.



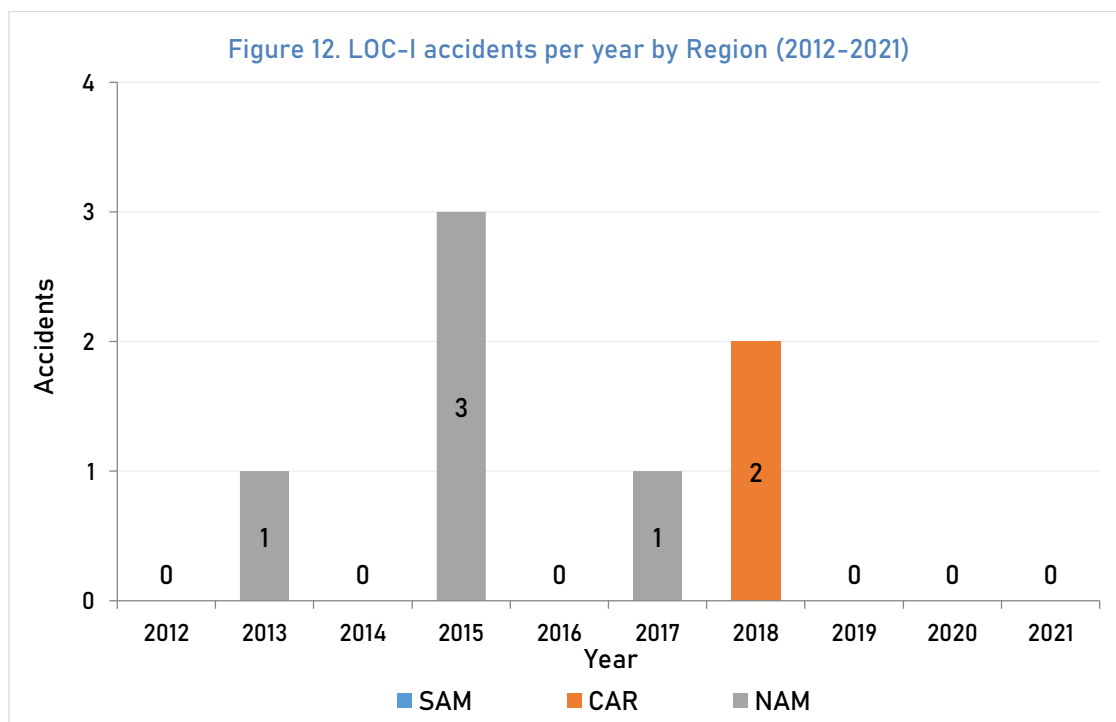
Contributing factors determined by IATA for Pan America CFIT accidents 2017-2021 were as the table below:

Table 6. Contributing factors to CFIT (2017–2021)

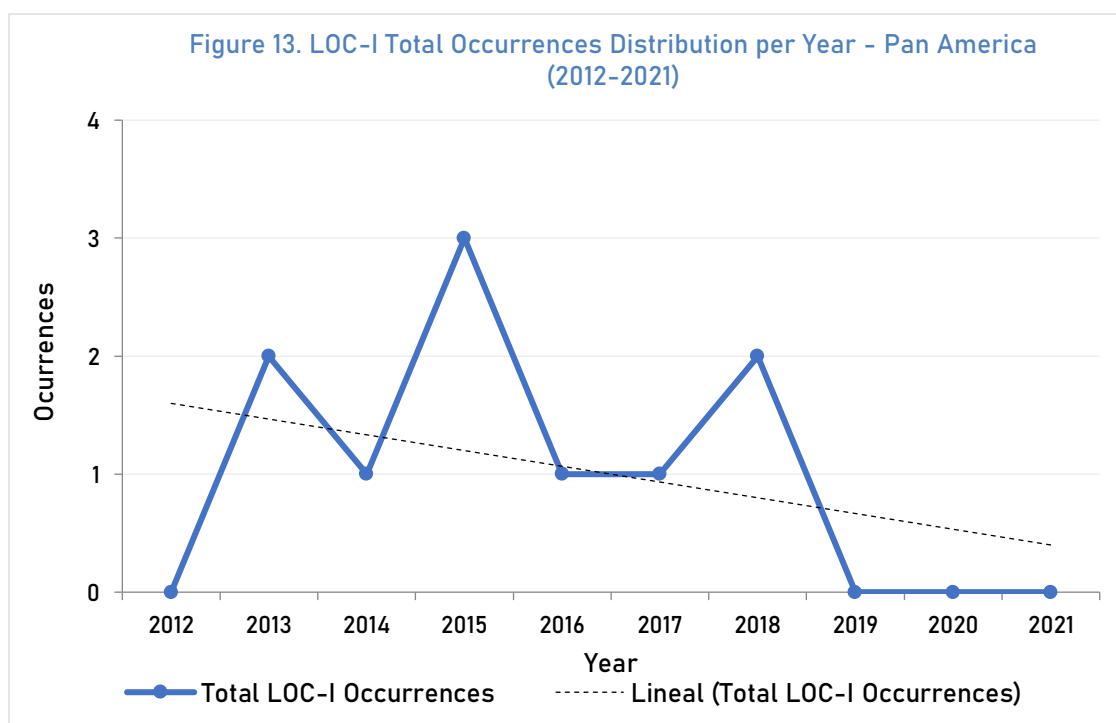
Latent conditions	Regulatory Oversight (71%) Safety Management (57%) Flight Operations (57%) Management Decisions (43%) Selection Systems (43%) Flight Ops: SOPs & Checking (43%)
Threats (Environmental)	Meteorology (86%) Poor visibility / IMC (86%) Nav Aids (43%) Terrain/Obstacles (43%) Lack of Visual Reference (29%)
Threats (Airline)	Ground-based Nav Aid Malfunction or not Available (43%) Operational Pressure (43%) Aircraft Malfunction (14%)
Flight Crew Errors	SOP Adherence / SOP Cross-verification (57%) Manual Handling / Flight Controls (43%) Callouts (43%) Failure to GOA after Destabilization on Approach (14%) Pilot-to-Pilot Communication (14%)
Undesired Aircraft States	Unnecessary Weather Penetration (57%) Vertical/Lateral/Speed Deviation (43%) Abrupt Aircraft Control (29%) Engine (29%) Operation Outside Aircraft Limitations (29%) Unstable Approach (29%)
Countermeasures	in-flight Decision-making/Contingency Management (71%) Monitor/Cross-check (57%) Overall Crew Performance (57%) Captain Should Show Leadership (43%) FO is Assertive When Necessary (43%) Leadership (43%)

1.4.2 Specific analysis of Loss of Control In-flight

Accidents recorded by ICAO show a significant decreasing trend through the latest ten-year period, as presented in the following figure.



According to ICAO accident, serious incident and incident data, LOC-I total occurrences showed an average of 0.7 per year, with a decreasing trend in the period 2012-2021. The distribution of LOC-I occurrences per year is shown in the following figure.



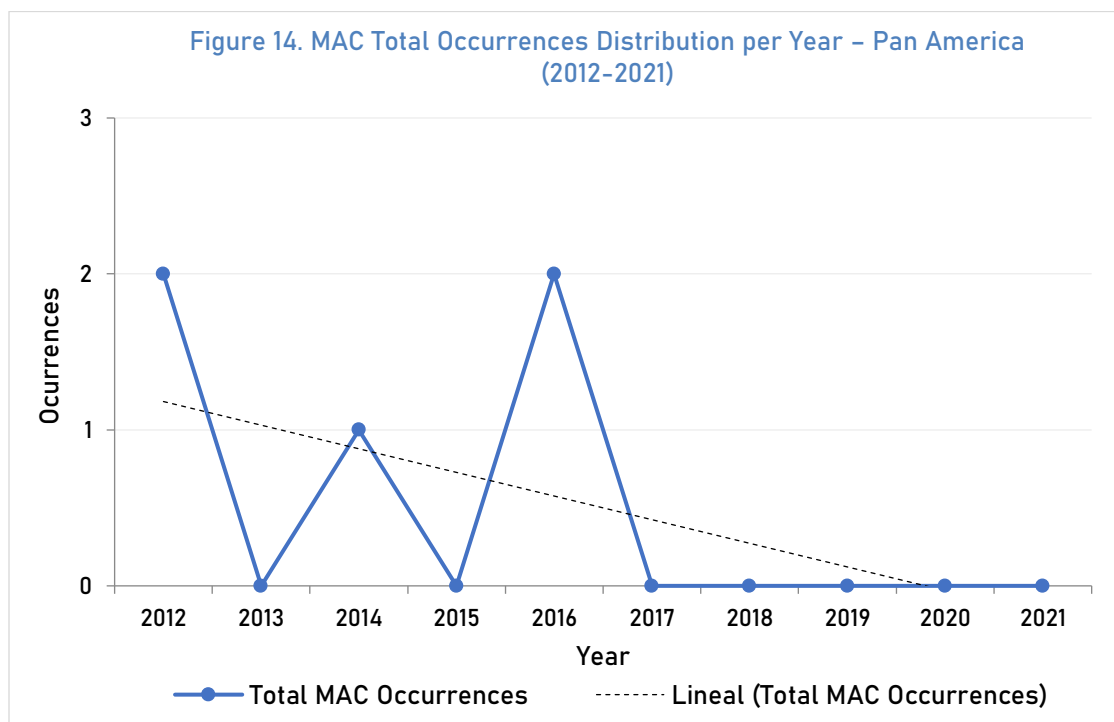
Contributing factors determined for Pan America Loss of Control In-flight 2017–2021 accidents by IATA were:

Table 7. Contributing factors to LOC-I (2017–2021)

Latent conditions	Safety Management (86%) Regulatory Oversight (79%) Management Decisions (64%) Selection Systems (57%)
Threats (Environmental)	Meteorology (50%) Icing Conditions (21%) Poor Visibility/IMC (14%) Thunderstorms (7%)
Threats (Airline)	Maintenance Events (29%) Ground Events (21%) Aircraft Malfunction (21%)
Flight Crew Errors	Manual Handling / Flight Controls (50%) SOP Adherence / SOP Cross-verification (50%) Pilot-to-Pilot Communication (21%) Documentation (21%)
Undesired Aircraft States	Vertical/Lateral/Speed Deviation (43%) Operation Outside Aircraft Limitations (36%) Abrupt Aircraft Control (21%) Flight Controls/Automation (21%)
Countermeasures	Overall Crew Performance (50%) Leadership (43%) Captain Should Show Leadership (36%) In-flight Decision-making/Contingency Management (36%)

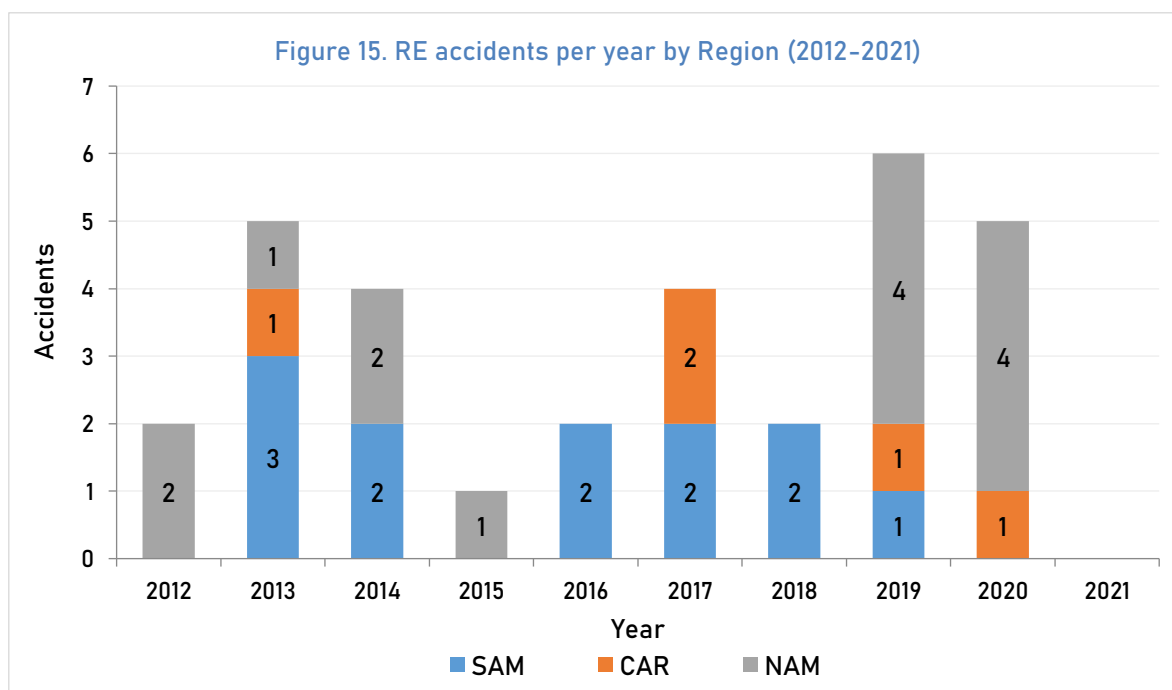
1.4.3 Specific analysis of Mid Air Collision

Accident, serious incident and incident data provided by ICAO, showed 5 MAC occurrences in total, for the time frame from 2012 to 2021, in the Pan American Region, with a decreasing trend, as presented in the following figure.

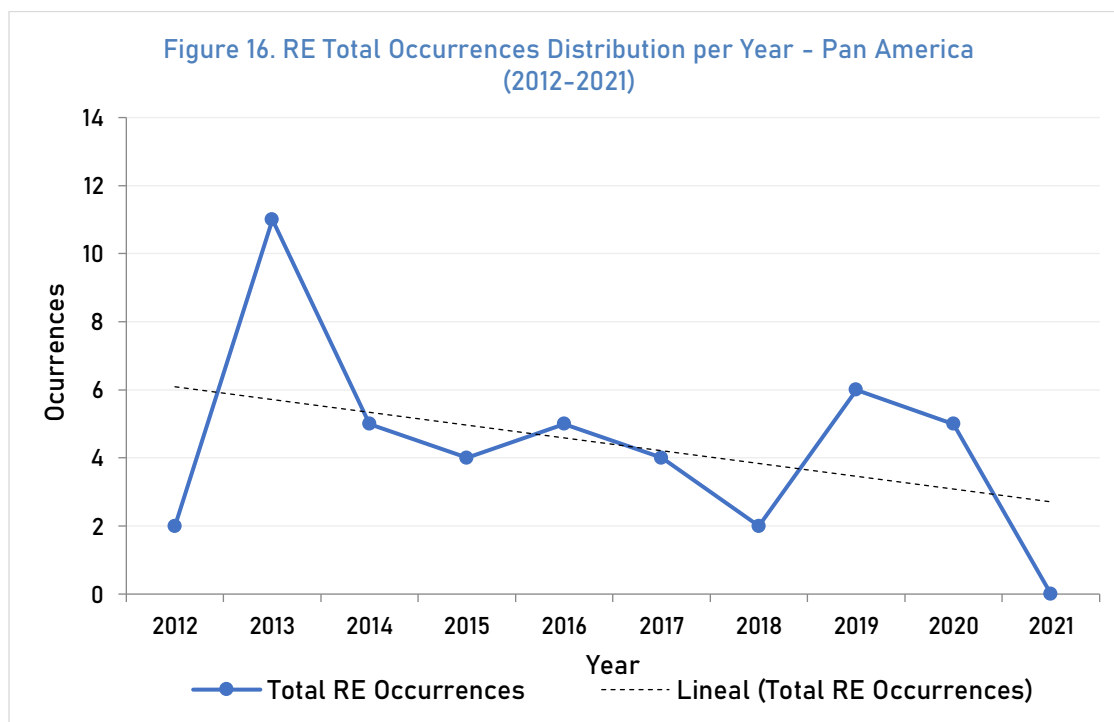


1.4.4 Specific analysis of Runway Excursion

Accidents recorded by ICAO for the 2012-2021 period show a decreasing trend, as presented in the following figure.



Accident, serious incident and incident data provided by ICAO, showed 31 Runway Excursions (an average of 3.1 per year) in the last 10-year moving period (2012-2021) with a decreasing trend. In 2021 there were no Runway Excursions in the region. The number of RE per year is depicted in the following figure.



Contributing factors for Pan America Runway Excursions 2017-2021 determined by IATA are shown in the following table:

Table 8. Contributing factors to RE (2017-2021)

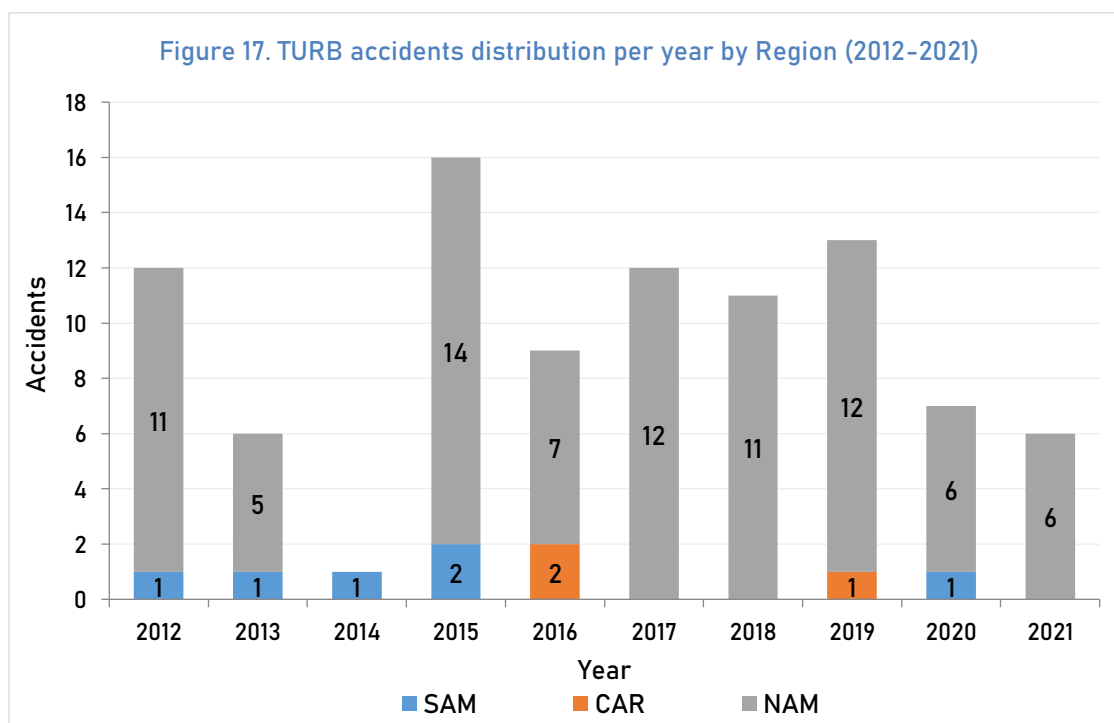
Latent conditions	Regulatory Oversight (36%) Safety Management (34%) Flight Operations (28%)
Threats (Environmental)	Meteorology (48%) Airport Facilities (43%) Wind/Windshear/Gusty Wind (33%) Contaminated Runway/Taxiway - Poor Braking Action (28%)
Threats (Airline)	Aircraft Malfunction (19%) Operational Pressure (10%) Maintenance Events (5%) MEL Item (5%)
Flight Crew Errors	Manual Handling / Flight Controls (41%) SOP Adherence / SOP Cross-verification (31%) Failure to GOA after Destabilization on the Approach (24%)
Undesired Aircraft States	Long/Floated/Bounced/Firm/Off-center/Crabbed Landing (31%) Unstable Approach (22%) Unnecessary Weather Penetration (22%) Continued Landing after Unstable Approach (22%)
Countermeasures	Overall Crew Performance (31%) In-flight Decision -making/Contingency Management (21%) Taxiway/Runway Management (21%) Leadership (19%)

1.4.5 Specific analysis of Turbulence

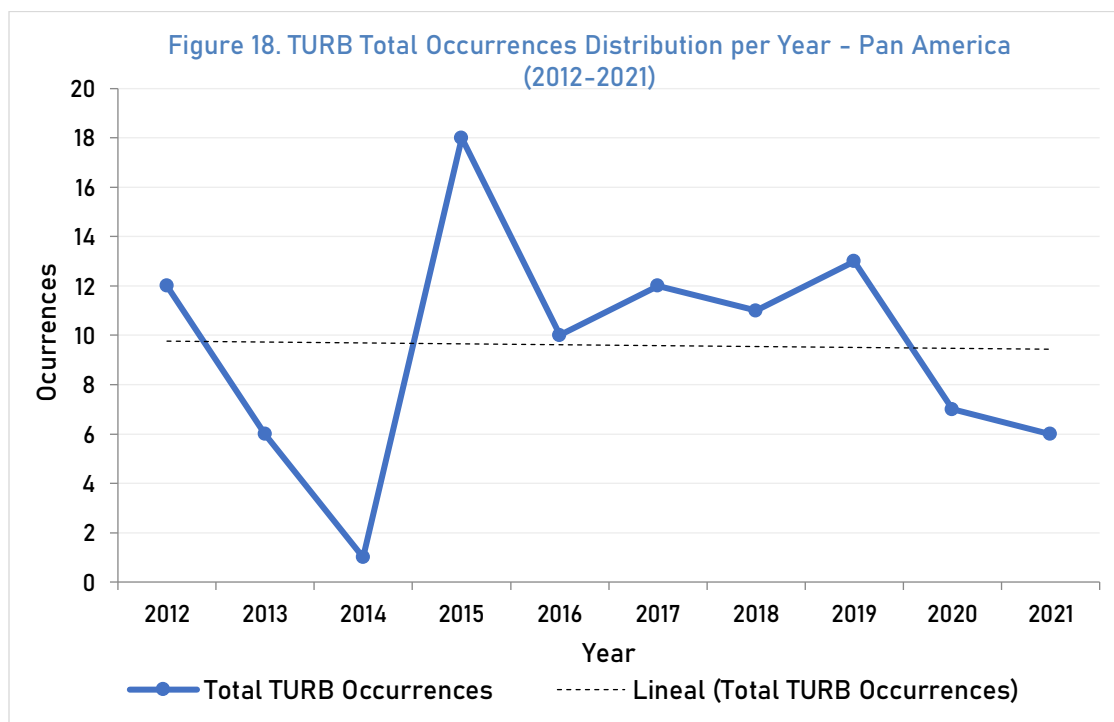
This year, ASR brings a specific analysis of events categorized as TURB. This analysis was recommended by ASR 2020 once it was reported that all the identified HRC (High Risk Category) previously mentioned in this Report presented a decreasing trend, while the total number of accidents presented a mild increasing trend.

This situation led ASR 2020 to classify TURB as an Additional Risk Category (ARC). The contributing factors assessed by IATA also highlighted this situation, as it can be seen in Tables 5 and 6, where Unnecessary Weather Penetration is presented as one of the top contributing factors to accidents both in CAR/SAM Region and to CFIT accidents.

Accidents recorded by ICAO for the 2012-2021 period show an increasing trend, as presented in the following figure.



Accident, serious incident and incident data provided by ICAO showed 93 occurrences involving turbulence (an average of 9,3 per year) in the last 10-year moving period (2012-2021), with a slowly increasing trend. The number of TURBs per year is depicted in the following figure.



As it can be seen in Figure 17, TURB reports in the NAM region represent 84 out of 93 accident reports, approximately 90% of all reported accidents in the Region, which exceeds the participation of 88% in the Region scheduled commercial flights shown in Table 3. Although NAM region is responsible for the vast majority of scheduled commercial flights in Pan American Region, reactive information analysis showed a great disparity among regions regarding TURB events reporting, which can indicate a geographically concentrated safety issue or can reflect an asymmetry in protocols, standards and procedures concerning mandatory and voluntary occurrence reporting in this specific matter.

The contributing factor “Unnecessary Weather Penetration” should also be analyzed to assess whether this contributed significantly to the events mentioned above or if there are other risks that might be identified from the TURB occurrences proper investigation. In addition to this procedure, one viable hypothesis to explain the great disparity among the Regions is the existence of significant differences between the reporting cultures of State, which might lead to great differences between NAM and other Regions regarding TURB total occurrences.

2. Proactive Safety Information

This section is intended to apply the proactive methodology to show the risk exposure level in aviation, based upon the results of safety oversight and management processes.

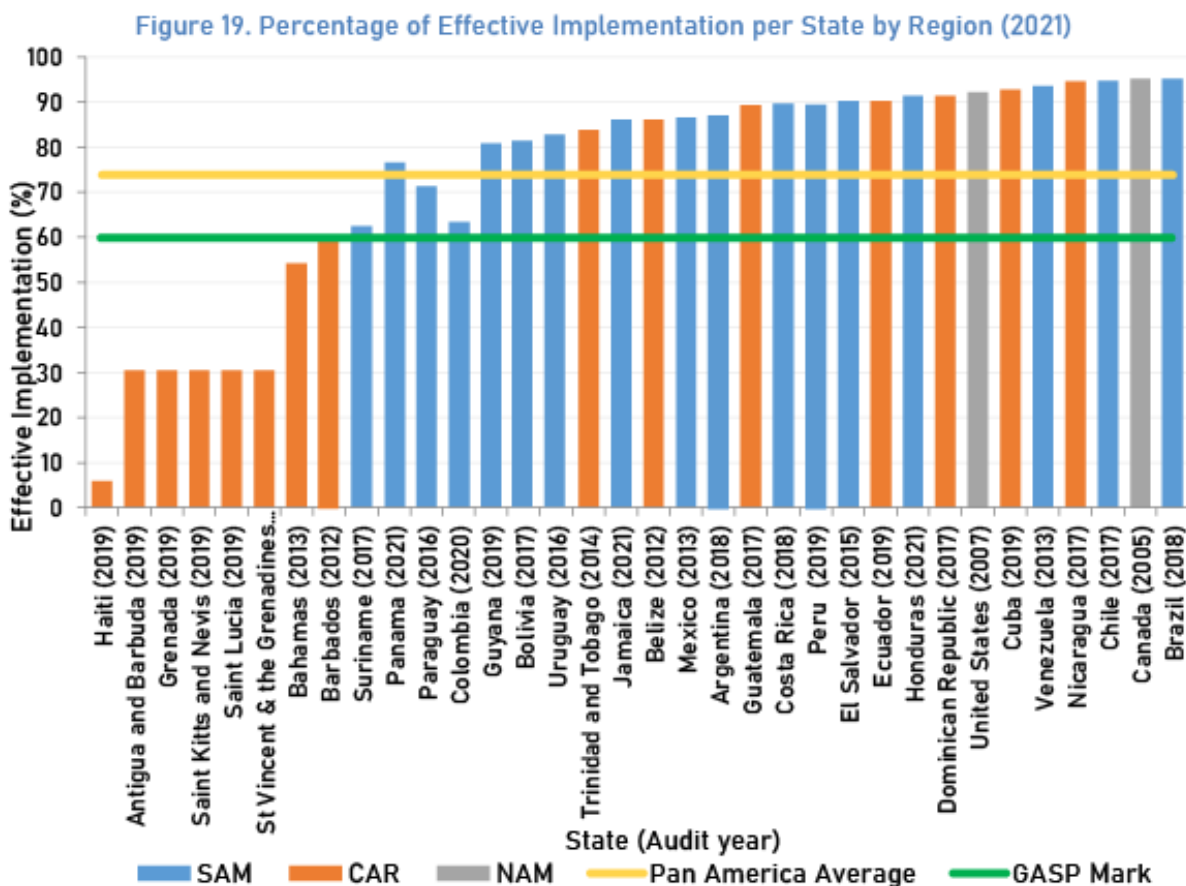
At the level of the States, ICAO USOAP-CMA results were used to establish the current context for safety.

2.1 Proactive information at the level of the States

2.1.1 ICAO Universal Safety Oversight Audit Programme – Continuous Monitoring Approach (USOAP-CMA)

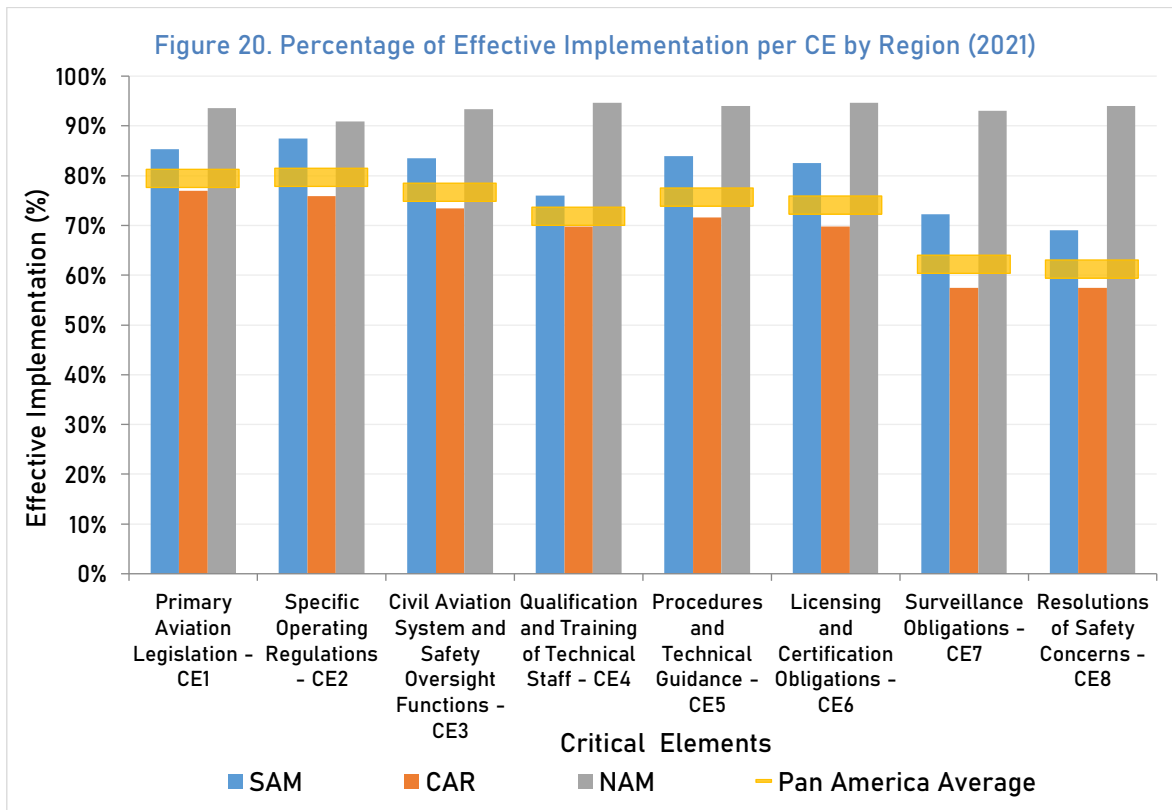
It is essential to ICAO that States establish, maintain and improve the eight critical elements of an effective safety oversight system, as well as the eight technical areas.

The following figure shows a detailed distribution of the percentage of Effective Implementation (EI) by State in the Pan American Region, based upon the latest USOAP audit or Coordinated Validation Mission (ICVM).

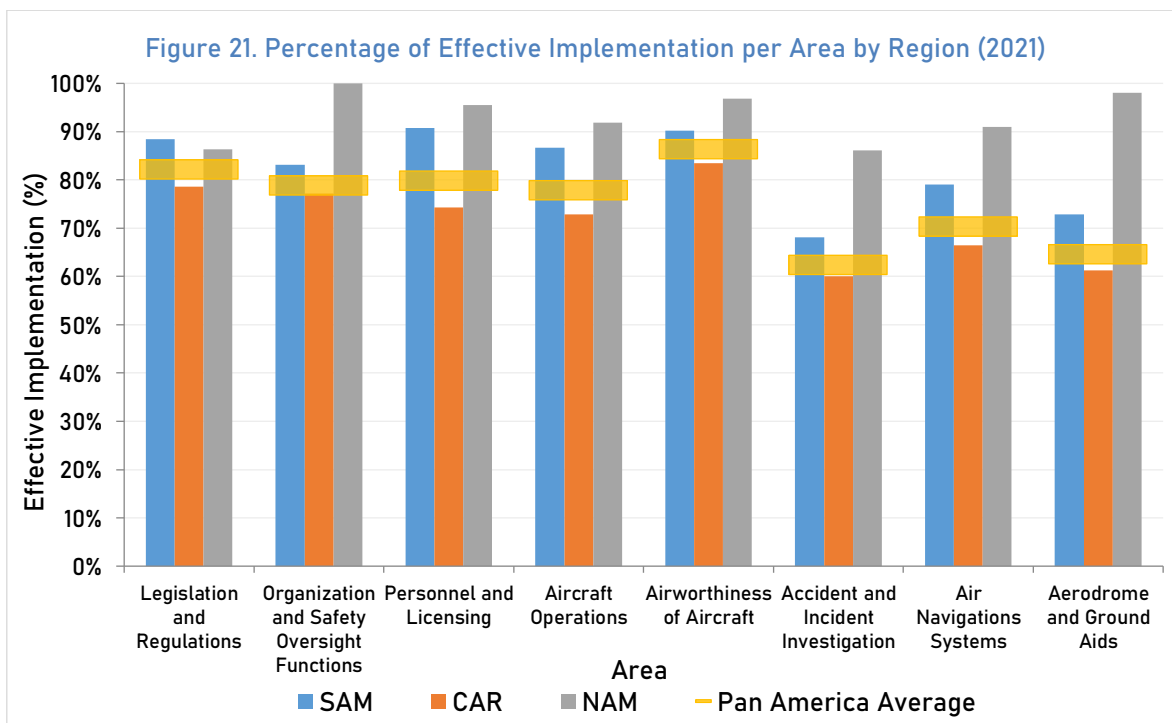


According to the previous chart, the average effective implementation in the Pan American Region is 73.82% as of December 2021. That value is above the world average of 70.62%. The average EI was 65.49% for CAR region states, 82.94% for SAM and 93.64% for NAM states. Also, it was verified that 79.4% of the States in the RASG-PA region have achieved the target of 60% EI, as suggested by the Global Aviation Safety Plan (GASP). According to ICAO GASP, States should target their efforts to increase and maintain effective implementation above 60%.

According to ICAO USOAP and ICVM information, the CEs showing the lowest percentage of effective implementation in the Pan American Region still remains CE7: Surveillance obligations and CE8: Resolution of Safety Concerns. This and other facts are shown in the following figure:



Regarding the eight technical areas, AIG, AGA and ANS continue to be the areas that show the lowest levels of effective implementation, especially in the CAR Region, as presented in the following figure:



To determine the correlation of areas and critical elements, an analysis of the allocation of findings was conducted, using the integrated Safety Trend Analysis and Reporting System (iSTARS). The following tables show the average findings per area and critical element for each Region.

Table 9. NACC Region USOAP CMA average finding per Area vs. CE (2021)

^A CE	LEG	ORG	AIG	PEL	OPS	AIR	ANS	AGA
CE1	2		3		1		1	1
CE2	2		4	3	3	4	2	6
CE3		2	4	2	1	1	5	2
CE4			2	2	2	1	6	3
CE5	1		18	2	4	3	1	5
CE6				8	16	4	9	17
CE7				4	4	2	18	12
CE8			5	2	1	2	3	4

In the case of the NACC Region, the highest numbers were in ANS/CE7, specifically regarding the existence of a flight data analysis programme as part of the operator's Safety Management System (SMS), and in AIG/CE5 in relation to the provision of technical guidance, tools and safety-critical information, as applicable, to technical personnel.

In the case of CAR Region, main findings regarding AGA/CE6 were related to the systems in place in the States to ensure certain aspects of aerodromes certifications such as documentation clearance, compliance with the regulations by the aerodrome operator, especially with regard to aerodrome data, determination and reporting of pavement bearing strengths, emergency plans and provision of power supplies.

Table 10. SAM Region USOAP CMA average finding per area vs. CE (2021)

CE ^A	LEG	ORG	AIG	PEL	OPS	AIR	ANS	AGA
CE1	1		4					
CE2	1		3	1	2	2	1	2
CE3		1	3		1	1	2	1
CE4			2	1	1	1	6	2
CE5			12		1	1		2
CE6				3	8	3	4	12
CE7				2	2	1	11	9
CE8			3	1	1	1	3	3

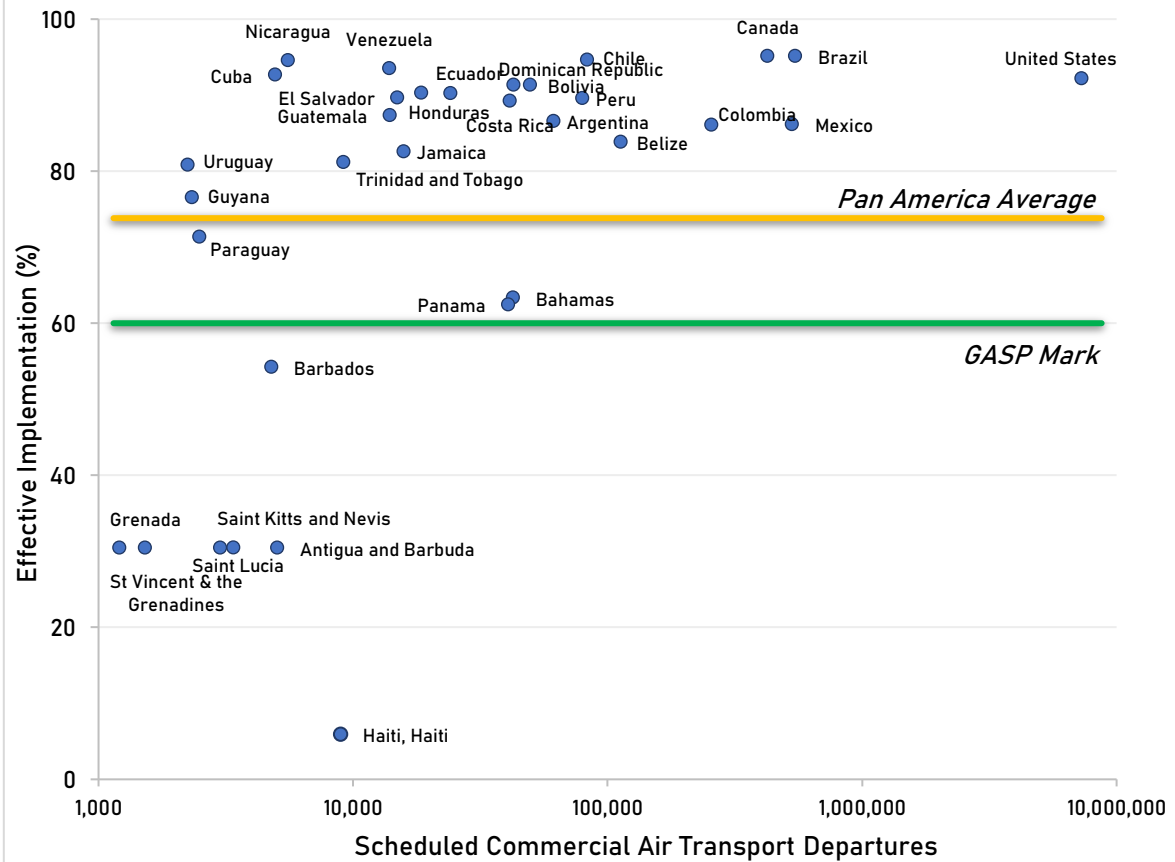
In the case of SAM Region, the highest numbers were reached in AIG/CE5 and AGA/CE6, mainly on the assurance of aerodrome operators employing competent personnel for critical activities, a quality system to ensure data compliance, integrity, accuracy and protection, safety of the runway surrounding areas and integration of lighting, marking and signals as part of the aerodrome's runway incursion and collision avoidance strategy.

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 operations are expected to account for 74% of the total passenger traffic from, to and within the regions. However, this thorough analysis was issued before the COVID-19 pandemic, which will certainly impact its accuracy on a short-term period, while due update in long-term analysis from ICAO and other organizations is still pending and will need to assess the full impact of the pandemic in order to be properly updated.

Even with all the uncertainties regarding the future traffic growth, the RASG-PA highly recommends that the CAR and SAM Regions continuously monitor and improve the implementation of the ICAO Standards and Recommended Practices (SARPs), especially in CE7 and CE8, and also in the areas of ANS, AGA and AIG.

Figure 22 shows a comparison between EI and traffic volume (departures) by Pan American States in 2021 based upon ICAO iSTARS (State Traffic) data, which could be an indicator for risk exposure to States.

Figure 22. Effective Implementation vs. departures by State (2021)



Part Two: Safety Intelligence

This part of the report is intended to present correlations and conclusions based on the information contained in the first part.

To be consistent with the structure of the first part of the report, conclusions are described according to the safety analysis methodologies, and correlations are the result of the cross-sectional analysis, thus increasing the frame of reference for the safety decision making process.

1. Conclusions based on reactive information

- Accidents in the Pan American Region showed a decreasing trend across the ten-year period analyzed (2012-2021), both in absolute values and in accident rates per million departures, as it can be inferred from the data presented in Appendix A.
- The analyzed reactive data also highlighted that Loss of Control In-flight (LOC-I), Runway Excursion (RE) and Controlled Flight into Terrain (CFIT) continue to be the top categories of interest in the Pan American Region. All high risk categories showed decreasing trends across the period.
- In addition, to the Mid-Air Collision (MAC) category, serious incidents and incident data showed a downward trend.
- With regard to TURB occurrences, for the second consecutive year this category shows an increasing trend, particularly with occurrences reported by NAM region. The increasing trend presented in this report reinforces the need of safety enhancements regarding this subject, which makes the latest initiatives from PA-RAST, that recently added severe weather as an additional risk and is in the early stages of implementing safety enhancements to address its respective emerging risks, extremely important. The asymmetry between Regions in reporting TURB occurrences might indicate the need of focusing these safety enhancements or, in an alternate hypothesis, shows the necessity of improvement in the reporting culture for TURB events throughout the Region.
- Management decisions, Safety management, and Regulatory oversight were identified as the top latent conditions for 2017-2021 accidents in the both North America and Latin America & Caribbean regions.

2. Conclusions based on proactive information

- Since the last edition of this report, the level of effective implementation (EI) of the critical elements (CEs) below 60% keeps at 8 States in the Pan American Region according to the ICAO Universal Safety Oversight Audit Programme - Continuous Monitoring Approach (USOAP-CMA). However, it must be highlighted that, due to COVID-19, most of USOAP-CMA activities were heavily impaired, which may have delayed to the next years any changes in EI from the States of the Pan American Region.
- USOAP findings on Licensing and Certification obligations (CE 6) in the Aerodromes and Ground Aids area (AGA) area was the most common in PA Region, related to aerodrome data, runway safety areas and runway incursion and collision avoidance.

- Furthermore, due to the forecasted increase in regional traffic, risk exposure of the States in the CAR and SAM Regions could be affected due to low EI in Air Navigation Systems (ANS) including Aerodromes and Ground Aids (AGA) areas.

3. Safety Intelligence correlations

- Accidents and their precursors, presented in the first part of the report, provide a perspective of the entire aviation system about safety. To manage safety in an efficient manner, it is important to maintain reliability in safety information and intelligence, which is only achievable by developing and improving safety data gathering, validation, exchange and analysis processes.
- Even though different stakeholders maintain their own initiatives for safety data collection and analysis, the development of safety reports could allow the aviation community to obtain a harmonized view of the aviation system. Stakeholders are encouraged to use ADREP, US CAST, ISARPs and other standardized taxonomies, which could facilitate addressing a shared comprehension of conditions and situations related to safety.
- Technological improvement in the aviation system requires fast and complete data exchange. In the age of intelligence, data availability is key to be up to date. Applied to safety, decision making based on information supported by data should allow proper and timely response to key issues. Stakeholders are invited to use the areas shown in this Annual Safety Report to develop more in-depth analysis oriented to support the establishment of indicators, acceptable levels of safety and safety targets.

List of Scheduled Commercial Accidents in 2021 Pan-America

Local Date	Model	State of Occurrence	RASG Region	Fatalities	Occurrence Category
2021-02-08	Airbus A320	United States	PA		AMAN
2021-03-15	Boeing 777	United States	PA		TURB
2021-03-16	Bombardier CL600	United States	PA		CABIN; OTHR
2021-03-18	Airbus A320	Mexico	PA		SCF-NP
2021-03-28	Embraer E145	United States	PA		TURB; WSTW
2021-05-21	Boeing 737	United States	PA		GCOL
2021-05-28	Boeing 737	United States	PA		GCOL
2021-06-25	Airbus A321	United States	PA		TURB
2021-07-04	Airbus A321	United States	PA		TURB
2021-07-22	Airbus A321	United States	PA		AMAN
2021-08-21	Airbus A319	United States	PA		TURB
2021-08-23	Boeing 737	United States	PA		EVAC; F-NI
2021-08-25	BEECH 1900	Canada	PA		SCF-NP
2021-08-27	Canadair CRJ-900	Canada	PA		ARC; CABIN
2021-09-01	Boeing 767	United States	PA		AMAN
2021-09-17	Bombardier CL600	United States	PA		GCOL
2021-09-23	Airbus A321	United States	PA		ARC
2021-09-27	Boeing 757	United States	PA		ARC
2021-10-01	Embraer E170	United States	PA		GCOL
2021-10-08	Boeing 737	United States	PA		TURB
2021-10-23	Embraer E170	United States	PA		RAMP
2021-11-25	Airbus A320	Brazil	PA		SCF-NP; EVAC
2021-12-13	Airbus A320	United States	PA		ARC
2021-12-15	Airbus A321	United States	PA		MED
2021-12-21	Airbus A321	United States	PA		RAMP
2021-12-25	Airbus A330	Canada	PA		SCF-NP
2021-12-30	Embraer E170	United States	PA		GCOL

Source of data: ICAO SAM and NACC Regional Offices

Note: ICAO databases are constantly being updated. Therefore, there might be some minor changes in information between RASG-PA Annual Safety Report 2021 and other publications provided by ICAO.

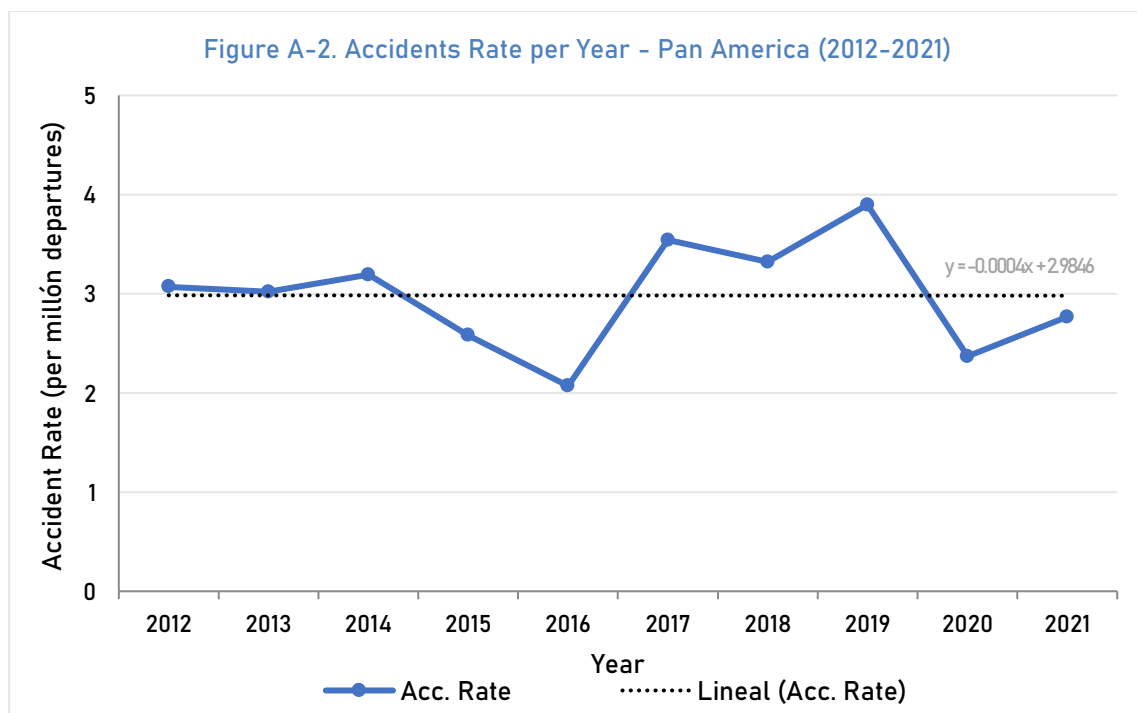
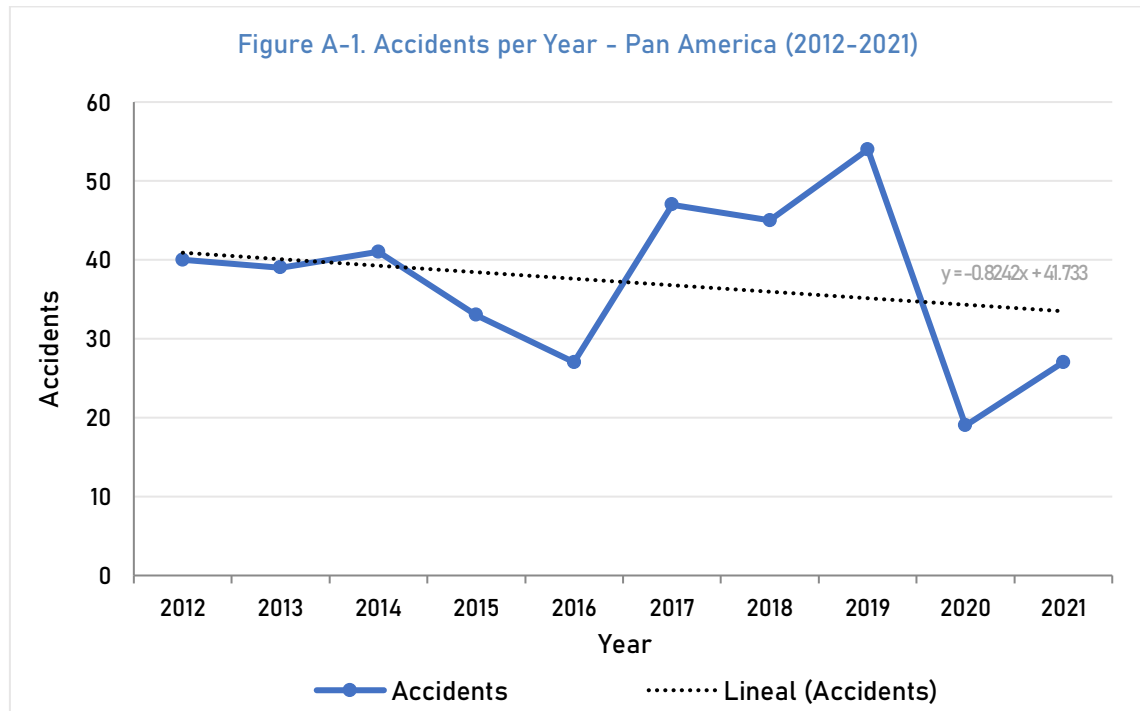
List of Acronyms

ADREP	Accident/Incident Data Reporting System (ICAO)	FLT	Flight Operations (IOSA)
ADRM	Aerodrome	F-NI	Fire/smoke (none-impact).
ARC	Abnormal Runway Contact	FOQA	Flight Operations Quality Assurance
AFI	Africa (IATA Region) and Regional Aviation Safety Group-Africa-Indian Ocean (RASG-AFI)	F-POST	Fire/Smoke (post-impact)
AGL	Above Ground Level	FUEL	Fuel related
AIG	Accident and Incident investigations	GASP	ICAO Global Aviation Safety Plan
AIS	Aeronautical Information Service	GCOL	Ground collision
AMAN	Abrupt manoeuvre	GPWS	Ground Proximity Warning System
APAC	Regional Aviation Safety Group - Asia and Pacific Regions (RASG-APAC)	GRH	Ground Handling Operations (IOSA)
ARC	Abnormal runway contact	GSI	Global Safety Initiative
ARCM	AIG Regional Cooperation Mechanism	HRC	High Risk Category
ASPAC	Asia/Pacific (IATA Region)	IATA	International Air Transport Association
ASRT	Annual Safety Report Team	ICAO	International Civil Aviation Organization
ATM	Air Traffic Management, Communications, Surveillance	ICE	Icing
ATS	Air Traffic Services	ICVM	ICAO Coordinated Validation Missions
BIRD	Birdstrike	IDISR	Data Exchange Program of Ramp Safety Inspections
CAB	Cabin (IOSA)	IMC	Instrument meteorological conditions
CABIN	Cabin safety events	IOSA	IATA Operational Safety Audit
CAR	Caribbean (ICAO Region)	ISARPs	IOSA Safety and Recommended Practices
CARSAMMA	Caribbean and South America Regional Monitoring Agency	ISTARS	ICAO Integrated Safety Trend Analysis and Reporting System
CEs	Critical Elements (ICAO)	LALT	Low altitude operations
CFIT	Controlled flight into terrain	LAR	Latin American Aeronautical Regulation
CGO	Cargo Operations (IOSA)	LATAM/CAR	Latin America and Caribbean (IATA Regions)
CIS	Commonwealth of Independent States (IATA Region)	LHDs	Large Height Deviations
CMA	Continuous monitoring approach	LOC-G	Loss of control - ground
CR	Conformance Report (IOSA)	LOC-I	Loss of control - inflight
CRM	Collision Risk Methodology	MAC	AIRPROX/TCAS alert/loss of separation/near miss collisions/mid-air collisions
DGAC	Directorate General of Civil Aviation	MID	Regional Aviation Safety Group - Middle East (RASG-MID)
DIPs	Detailed Implementation Plans	MNT	Aircraft Engineering and Maintenance (IOSA)
DSP	Dispatch (IOSA)	MENA	Middle East and North Africa (IATA Region)
ECCAIRS	European Coordination Centre for Accident and Incident Reporting Systems	MOU	Memorandum of Understanding
E-GPWS	Enhanced Ground Proximity Warning System	MTOM	Maximum Take-off Mass
EI	Effective Implementation of ICAO SARPs	NAM	North America (ICAO and IATA Region)
ESD	Electrostatic Sensitive Devices	NASIA	North Asia (IATA Region)
EUR	Europe (ICAO and IATA Region) and Regional Aviation Safety Group - Europe (RASG-EUR)	OTHR	Other
EVAC	Evacuation	ORG	Organization and Management System (ORG)
FDA	Flight Data Analysis	PA-RAST	Pan America - Regional Aviation Safety Team
FDM	Flight Data Monitoring	RA	Resolution Advisory
FIR	Flight Information Region	RAIO	Regional Accident and Incident Investigation Organization
		RAMP	Ground handling operations
		RASG-PA	Regional Aviation Safety Group - Pan America

RASGs	Regional Aviation Safety Groups
RE	Runway excursion (departure or landing)
RI	Runway Incursion
RI-A	Runway Incursion – Animal
RI-VAP	Runway Incursion – vehicle, aircraft or person
RMA	Regional Monitoring Agency (CARSAAMA)
RVSM	Reduced Vertical Separation Minima or Minimum
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
SIMS	ICAO Safety Information Monitoring System
SMRT	Safety Monitoring and Report Team (RASG-PA)
SMS	Safety Management System
SOP	Standard Operating Procedure
SRVSOP	Regional Safety Oversight Cooperation System
TCAS	Traffic Collision and Avoidance System
TCAS RA	Traffic Collision and Avoidance System-Resolution Advisory
TEM	Threat and Error Management
TLS	Target Level of Safety (RVSM)
TURB	Turbulence encounter
UNK	Unknown or Undetermined
US CAST	Commercial Aviation Safety Team (United States)
USOAP	Universal Safety Oversight Audit Programme
USOS	Undershoot/Overshoot
WSTRW	Wind shear or thunderstorm

Appendix A

Complementary Reactive Information



Credits

RASG-PA thanks the members of the RASG-PA Safety Monitoring and Report Team (SMRT) that contributed to the elaboration of this RASG-PA Annual Safety Report.

